NAMRL-1251

LEVEL II

(12)

THE PREVALENCE OF HEARING LOSS AMONG SELECTED NAVY ENLISTED PERSONNEL

Ronald M. Robertson, John C. Page, and Carl E. Williams

September 1978

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSACOLA FLORIDA

Approved for public release: distribution unlimited

THE PREVALENCE OF HEARING LOSS AMONG SELECTED NAVY ENLISTED PERSONNEL.

Ronald M. Robertson, John C. Page and Carl E. Williams

Naval Medical Research and Development Command
MF51.524.023-2004

F51524

Final rpt.,

NAMRL-1251

Approved by

Ashton Graybiel, M.D.
Assistant for Scientific Programs

Released by

Captain R. E. Mitchel, MC USN
Commanding Officer

28 September 1978

12 87 P.

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSACOLA, FLORIDA 32508

SUMMARY PAGE

THE PROBLEM

No reliable body of data exists on the prevalence of hearing loss among naval enlisted personnel. Such data are vitally needed, not only to determine the extent to which hearing loss exists in such personnel, but also to further document the urgent need for implementation of hearing conservation programs throughout the Navy.

FINDINGS

The problem of hearing loss is more widespread than was anticipated. In many instances the hearing threshold levels of individuals in control group (least noise exposed) ratings and apprenticeships (HN, DN, HM, DT, MS, YN, PN, DK, TD, and AZ) approached hearing threshold levels of individuals in experimental group (most noise exposed) ratings and apprenticeships (AN, FN, EO, MM, EN, BT, AM, AD, AB, and AO). Overall, 12.5 percent of subjects in the control group and 25 percent of subjects in the experimental group demonstrated significant high frequency hearing loss. These percentages, when projected to the total population within the ratings studied, produce an estimate of approximately 32,000 personnel as having a significant high frequency hearing loss. Considering that this investigation examined only 20 percent of the approximately 80 ratings in the Navy, it is clear that the total number of naval personnel exhibiting hearing loss is indeed formidable.

ACKNOWLEDGMENTS

The authors are indebted to a great many people for their assistance during the course of this investigation. Without the cooperation and support of a vast number of individuals, the study's progress would have been seriously affected. Special recognition should be given at the outset to those individuals whose primary responsibility it was to collect the data: HM1 E. Lemons, HM2 D. Fuller, Mr. C. Sturdevant, and Mr. R. Rood - NAMRL, Pensacola, Florida, and Mr. L. Bruno of the San Diego Speech, Hearing and Neurosensory Center who supervised all testing in the San Diego area. Following is a listing by geographical location of those individuals who made significant contributions to the conduct of the study.

PENSACOLA, FL: LTjg Briere, Chief Fitch, LCDR A. A. Mincer, Chief Norris - NARMC Branch Clinic, NASP; CDR Kunkler - TRAWING 6 - NASP; HM2 Perkins - NARMC Branch Clinic - NAS Whiting; YN1 Cruz - NASP; LT J. T. Wells, PN3 T. W. Loonan, PN3 S. E. Priner - USS Lexington.

KEY WEST, FL: CDR Stetzer - NAVHOSP, NAS.

JACKSONVILLE, FL: Chief Durbin - NS Mayport; Chief Slack - NAS Cecil; HM3 Bacon - NRMC Branch Clinic, NAS Jacksonville.

CHARLESTON, SC: RADM J. T. Burke - COMSIX; CAPT E. B. McMahon - CO NRMC; CAPT J. C. Rivera, M. E. Sullivan - NRMC Branch Clinic CNSY;

LT W. R. Aliff, HMC F. R. Smith - NRMC Branch Clinic - NS Charleston.

NORFOLK, VA: Mr. J. Miller - NRMC; LCDR R. B. Gutshall, L. Morrisette, LTjg K. J. Radmore, HM2 K. A. Faulkner, HMC W. F. Basham, HM3 P. Johnson - NRMC Branch Clinic - NS Norfolk; M. M. Shipman, E. L. King - NRMC Branch Clinic - NNSY; Chief Woods, HN L. V. Butler, HM1 I. A. Dennis - NRMC Branch Clinic - NAS Oceana.

MERIDIAN, MS: LCDR J. D. Smith - NARMC Branch Clinic - NAS; Chief Ford-NAS.

GULFPORT, MS: LCDR Greene - NARMC Branch Clinic - CBC; LT Wallace, LT Woods - NCTC; LT Hetrick - MCB 61; LT Puncke - MCB 1; LT Cosgrove - MCB 33.

BREMERTON, WA: LCDR S. Cowles - NRMC; YN1 Hafer - MATVAQWINGPAC - NAS Whidbey; CWO Rich, CWO Crowhorn - USS Ranger - PSNSY.

SAN DIEGO, CA: HM3 Comber - NRMC Branch Clinic, NAS North Island; HM3 Parranto - NRMC Branch Clinic, NTC; R. Mah - NRMC Branch Clinic, NS; CDR Colley - 11th Naval District; CDR R. Crafts, HM3 S. C. Miller - USS Dixon; CAPT E. J. Heinkel, LT Harrington - NAVREGDENTCNTR; R. E. Sandlin, L. Bruno - San Diego Speech, Hearing and Neurosensory Center; CAPT F. Leisse-NRMC.

WASHINGTON, D. C.: LCDR L. Doptis - NMRDC; C. Crowe, LCDR Kristenson - NAVPERS.

NEW ORLEANS, LA: PNCM L. Cornett - EPMAC.

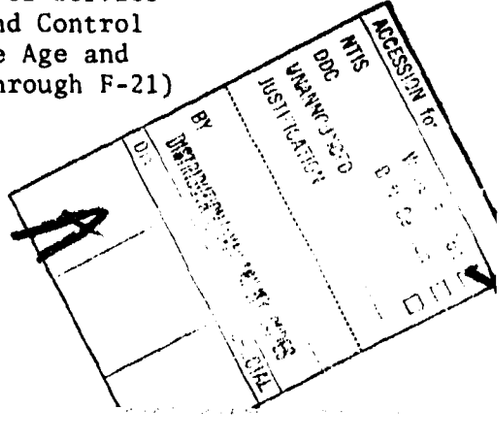
CORPUS CHRISTI, TX: LCDR Loughmiller - CNATRA.

Thanks are also extended to the professional and support staff of the Hearing Conservation Service, Naval Aerospace Medical Institute, who provided valuable consultations and assistance and who maintained and calibrated the audiometers used in the study. Finally, appreciation is extended to the 3530 individuals who voluntarily participated as subjects in the study.

- - - - - - - - - - -

Mr. Page is Head of the Clinical Audiology Branch, Hearing Conservation Service, Naval Aerospace Medical Institute, Pensacola, Florida.

TABLE OF CONTENTS



INTRODUCTION

Permanent hearing impairment caused by high intensity noise exposure is becoming an increasingly evident problem among naval personnel. There have been indications that reenlistments are down among personnel who work in high intensity noise environments, and increasing numbers of individuals are reportedly filing compensation claims for noise-induced hearing loss. Prior to the present investigation, no reliable body of data existed concerning the prevalence of hearing loss among Navy enlisted personnel. Although clinical experience suggested that the problem was widespread, this observation was impossible to document in any rigorous fashion. The present study was undertaken in order to: 1) determine the extent to which noise-induced hearing loss exists among Navy enlisted personnel; 2) establish a reliable information base on which management decisions could be founded; and 3) further document the urgent need for implementing effective hearing conservation programs throughout the Navy.

As Navy hearing conservation programs are implemented in accordance with BUMEDINST 6260.6B (4), it is anticipated that large numbers of hearing impaired personnel will be identified. Disposition of these individuals will be a problem; many should not be permitted to continue in naval service unless they are moved to a quieter work environment. Unfortunately, as is most often the case at the present time, these personnel are returned to their high noise level work environments where further auditory damage is probable. A Department of Defense hearing conservation instruction promulgated on 8 June 1978 (3) provides added incentive for the Navy to develop a workable disposition program. Information provided by the present investigation should be of value in providing an indication of the potential number of personnel that might be involved in such programs.

BACKGROUND

To serve as background for the present study, mention should be made of three studies from which data will be presented and discussed in conjunction with the data to be reported. The first study, entitled "The Prevalence of Hearing Loss Within Selected U. S. Army Branches," was published in August 1975 (12). The study involved the audiometric testing of 3300 subjects: 1000 from each of the artillery, infantry, and armor branches, and 300 recruits. The 1000 subjects in each branch were further classified into five time-in-service groups, covering a range from 1.5 to 22.5 years with 200 subjects in each group. No attempt was made to categorize the data into individual specialties. Audiometric testing included air conduction hearing threshold level measurements at 250-8000 Hz by manual audiometry, speech reception thresholds, and speech discrimination measures in quiet and was implemented through Army audiology officers in clinical ENT facilities at ten bases in the United States. Data from the various field locations were sent to the Army Audiology and Speech Center, Walter Reed Army Medical Center, for analysis.

The Army study indicated that approximately 20 to 30 percent of all personnel with two or more years of service in one of the three combat

branches had clinically significant hearing losses and that among soldiers with 15 years of service or more, the percentage exceeded 50 percent. The study showed that all three branches had the same percentage of personnel who exceeded the Army's H-1 hearing profile (about 23 percent). An H-1 profile is defined as average hearing threshold levels in each ear of not more than 25 dB for 500, 1000, and 2000 Hz, no level greater than 30 dB at these frequencies and not over 45 dB at 4000 Hz. Anything exceeding an H-1 profile is considered clinically significant.

The second study, involving a large survey of the hearing levels of Marine Corps personnel at Camp Lejeune, North Carolina, was reported by Abramson and Goldenberg in 1974 (1). The survey included air conduction hearing threshold level measurements (primarily by self-recording audiometry) at six frequencies between 500 and 6000 Hz. Data were presented for various military occupational specialties (MOS) by length of service and were expressed as the percentage of subjects showing significant low- and high-frequency hearing losses.

The Marine Corps survey revealed a 32 percent incidence of high-frequency hearing loss (68 percent for personnel with 11-20 years of service) and a 7 percent incidence of low-frequency hearing loss. Concluding that while they could only approximate the actual number of active duty personnel whose performance was restricted, the authors stated that "the reduction of the overall number of active duty personnel for training and combat readiness is obvious." They recommended further detailed studies in this area.

The third study to be mentioned is the Public Health Service National Health Survey of 1960-62 (7). The Public Health Service (PHS) data were derived from air conduction hearing threshold level measurements at six frequencies from 500 to 6000 Hz. All subjects were tested by manual audiometry in specially constructed mobile test vans. The PHS data were the first, and remain the most current, findings available from a nationwide probability sample of adults in the United States. Data from the PHS study will be cited in most of the graphic presentations to follow.

PROCEDURE

Table I outlines the study design. Based upon the experience of the laboratory staff and with the assistance of senior medical personnel, the apprenticeships and ratings shown were chosen for inclusion in the study. Those respondents were asked to rank order the 15 most noise exposed ratings and the 10 least noise exposed ratings and from this information, the experimental (most noise exposed) and the control (least noise exposed) groups were established. Included in each group were two apprenticeships and eight ratings. Furthermore, for the apprentice groups, four, one-year interval length of service (LOS) categories were established and, for the various ratings, eight LOS categories were defined: one-year intervals through five years of service and five-year intervals through twenty-five years of service.

Table I

Study Design

I. Subject Groups:

A. Experimental		B. Control	
1. Airman (E1-E3)	AN	1. Hospitalman (E1-E3)	HN
2. Fireman (E1-E3)	FN	2. Dentalman (E1-E3)	DN
3. Equipment Operator	EO	3. Hospital Corpsman	HM
4. Machinist Mate	MM	4. Dental Technician	DT
5. Engineman	EN	5. Mess Management Spec.	MS
6. Boiler Technician	BT	6. Yeoman	YN
7. Aviation Mechanic	AM	7. Personnelman	PN
8. Aviation Machinist Mate	AD	8. Disbursing Clerk	DK
9. Aviation Boatswain Mate	AB	9. Training Device Technician	TD
10. Aviation Ordnanceman	AO	10. Aviation Maintenance Admin	AZ

II. Length of Service Categories (LOS):

A. Apprenticeships: (AN,FN,HN,DN) 0-1, 1-2, 2-3, 3-4 years
B. Rated Personnel: 1-2, 2-3, 3-4, 4-5, 5-10, 10-15, 15-20, 20-25 years

III. Number of Subjects Proposed:

A. 100 in each of the four apprentice groups (25 for each of the four LOS categories)	400
B. 200 in each of the sixteen rated groups (25 for each of the eight LOS categories) for both experimental and control groups	3200
C. Recruit baseline measurements	120
Total Number of Subjects	3720*

IV. Data Collection:

A. Air conduction hearing threshold levels and bone conduction hearing threshold levels when necessary (when the sum of the hearing threshold levels at 500, 1000, and 2000 Hz was equal to or greater than 45 dB, unmasked bone conduction at 1 kHz was done).
B. Questionnaire (covering medical and noise history as well as current noise exposure).
C. Manual audiometry only.
D. Trained technicians or audiologists.
E. Mini-booths, shipped to test site in some cases.

- - - - - - - - - - -

*Data were actually obtained on a total of 3530 subjects (95 percent completion rate).

Since the purpose of this study was to report on the actual degree of hearing loss that exists in enlisted personnel, corrections for age were not applied to the data.* Presbycusis corrections would have been small had they been applied since the average age of the oldest group in this survey was 40 years. Estimates of the average presbycusis correction for 3000 through 6000 kHz at this age vary from 6 dB (6) to 9 dB (5,8,9).

A target figure of 3720 subjects was established — 400 for the apprenticeships, 3200 for the 16 ratings, and 120 recruits. Subjects were, in most cases, identified by computer. Names were supplied by NAVPERS in Washington and the Enlisted Personnel Management Center (EPMAC) in New Orleans. Tests were conducted in over eighteen geographic areas (some more than once). Among sites included in the survey were Pensacola, Meridian, Key West, Norfolk, Whidbey Island, and San Diego.

A total of 3530 subjects were actually tested for a completion rate of 95 percent. Females comprised 9 percent of the overall study population: 18 percent of the recruits, 16 percent of the control group, and 1.7 percent of the experimental group. The distribution of female subjects by rating is shown in Appendix A.

Audiometric tests were conducted with manual audiometers and included a determination of air conduction hearing threshold levels at seven frequencies from 500 to 8000 Hz. Bone conduction screening was done at 1 kHz when the sum of the air conduction levels at 500, 1000, and 2000 Hz was equal to, or greater than, 45 dB. Subjects showing evidence of conductive hearing losses were excluded from the study. The exclusion rate for individuals with suspected conductive hearing loss was 1.3 percent (46 subjects).

Data were obtained by trained audiometric technicians, except in the San Diego area where the services of an audiologist were contracted. With the exception of Charleston and San Diego where testing was conducted in audiometric test vans, testing was conducted in audiometric test booths located in naval regional clinics. At those locations where sound rooms in regional clinics were unavailable due to normal workload, compact audiometric sound rooms were shipped from Pensacola to the test site. All test environments were checked for background noise level to ensure that accurate hearing thresholds could be obtained. Audiometers were calibrated to the ANSI-1969 Standard (2). Physical calibration of audiometers was recent in all cases, and daily calibration checks were made against the technician's own hearing.

Each subject was requested to complete a questionnaire which covered his medical history and his past and current noise exposure histories (see Appendix B).

- - - - - - - - - - -

*The correspondence between increasing hearing loss and increasing age is well known. In the absence of occupational noise exposure this phenomenon is called "presbycusis" or hearing loss due to aging. To account for the possible added influence of a generally noisy society, the term "sociocusis" has also been used.

RESULTS AND DISCUSSION

Figure 1 shows the comparability of hearing level data obtained from the Navy recruits with recruit data from the Army study and data for the 18 to 24 year old age group in the Public Health Service (PHS) study.* A difference of 6 dB between the Army and Navy findings at 6000 Hz is the only discrepancy. As can be seen, 8000 Hz was not tested in the PHS study. Comparable findings have also been reported for Air Force personnel of the same age (11). Considering the fact that the PHS data are 15 years old, the similarity among these data is remarkable. The assumption, often made, that our society is becoming noisier apparently has not manifested itself in decreased hearing levels among enlistees. Since there were no clinically significant differences in our study in hearing levels between ears (as was the case in the Army and Air Force studies), right and left ear hearing threshold level data have been pooled and are presented as a single threshold.

Figure 2, from the Army study, shows hearing threshold levels plotted over frequency for several time-in-service categories. It is clear that as time-in-service increases, high frequency loss increases. This finding will also be demonstrated in data from the present investigation. The degree of high frequency hearing loss is much greater than would be produced by aging alone.

Figure 3 shows the increase in high frequency hearing loss over time for individuals in the equipment operator (EO) rating. Shown are data for the 1- to 2-year and 15- to 20-year LOS categories. This substantial worsening of hearing over time was fairly typical of all the experimental ratings, with the EO rating displaying the poorest hearing levels. Average hearing levels for the recruits are shown in the upper curve; included also are hearing level data from the PHS study for 35- to 44-year old males. The average age of EO subjects in the 15- to 20-year LOS category was 38 years. It is clear that individuals in the EO rating group are displaying much poorer hearing than their counterparts in the general population. In order to simplify the graphic presentations, data for the six intermediate LOS categories are not shown but appear in an appendix to this paper.

Figure 4 presents a comparison of the 15- to 20-year LOS EO data with hearing level data from two other studies. The PHS curve is also shown again as a reference. The predictive data of Passchier-Vermeer (8) are shown for the 50th percentile for workers with 20 years of service and documented exposure to noise levels of 95 dBA. Also shown are the findings of Gallo and Glorig (5)**obtained for the same conditions described in the Passchier-Vermeer study. When the high frequency pure tone average (3000,

- - - - - - - - - - -

*To permit direct comparison with results of the present study, all PHS data were converted to the current American National Standard Institute (ANSI) standard (2) from the earlier ASA standard.

**Data have been converted to the current ANSI standard (2).

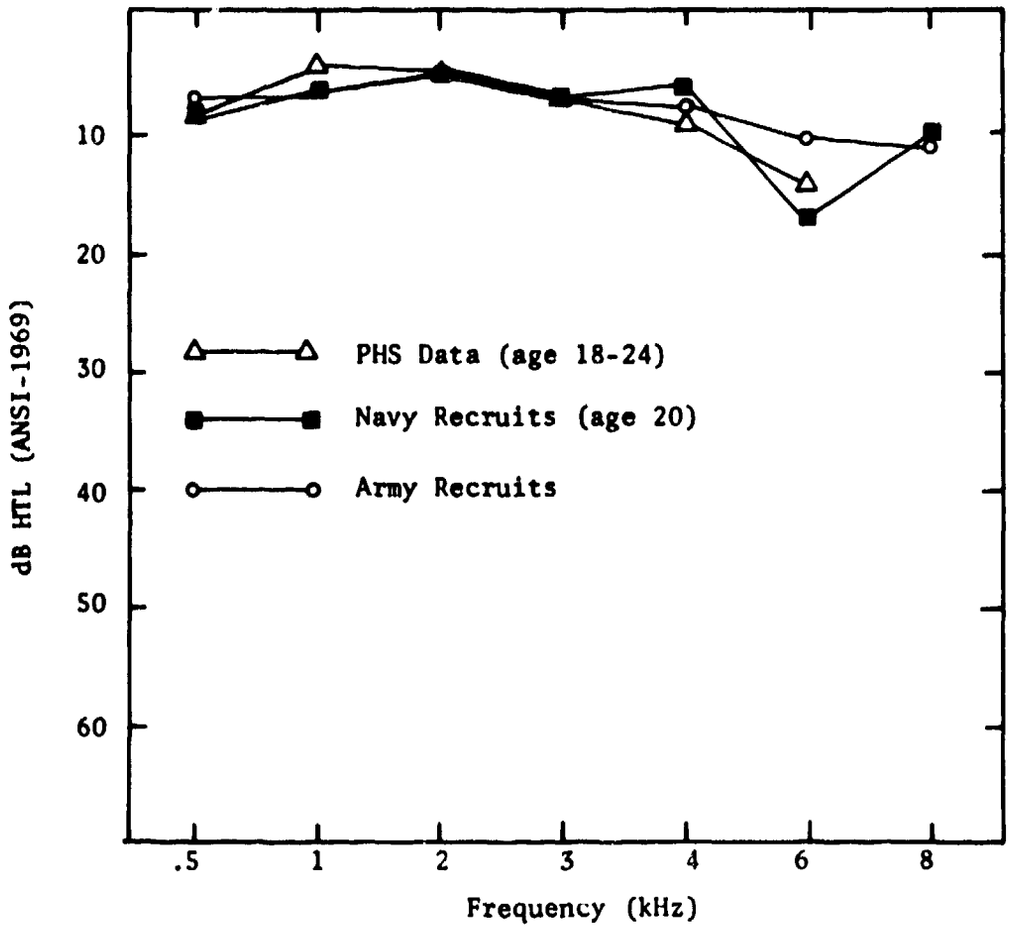


Figure 1

Comparison of Army and Navy recruit hearing threshold level data with Public Health Service (PHS) data for the same age group (mean ages).

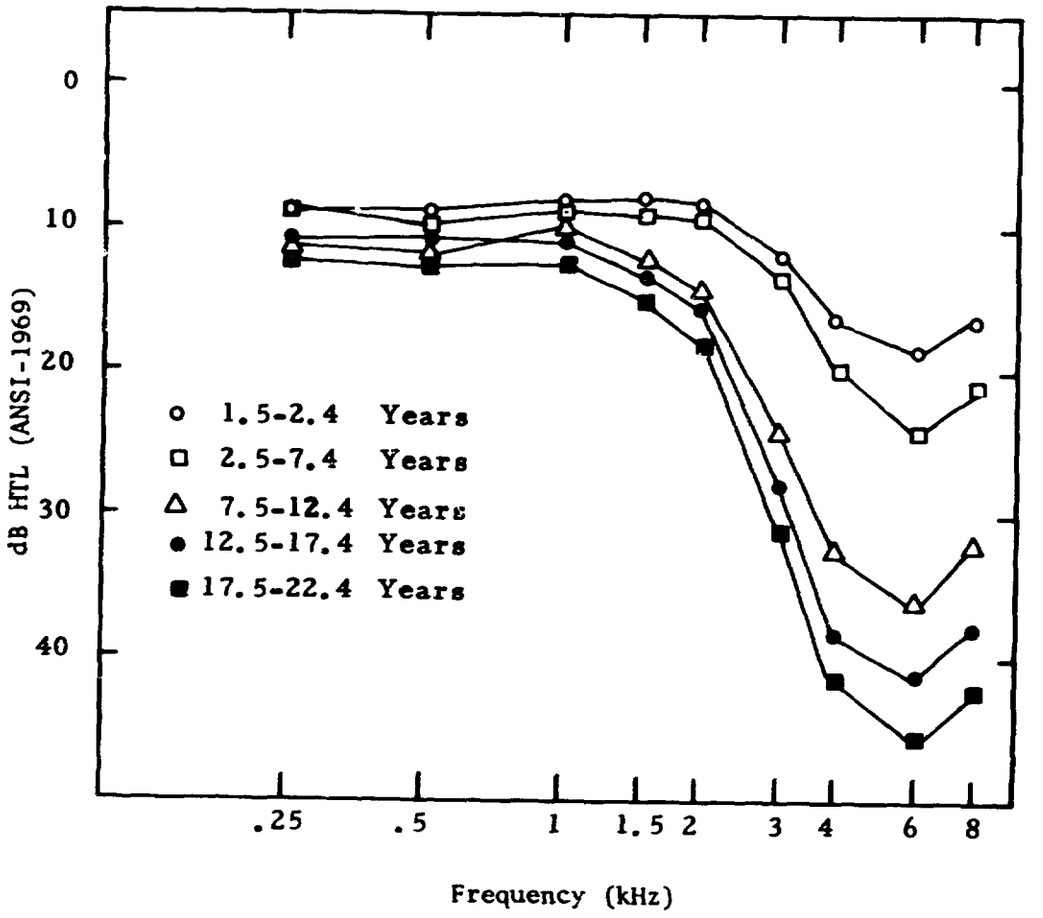


Figure 2

Mean audiograms (Army study, 1974) for the five time-in-service categories. Data are weighted to reflect differing population sizes.

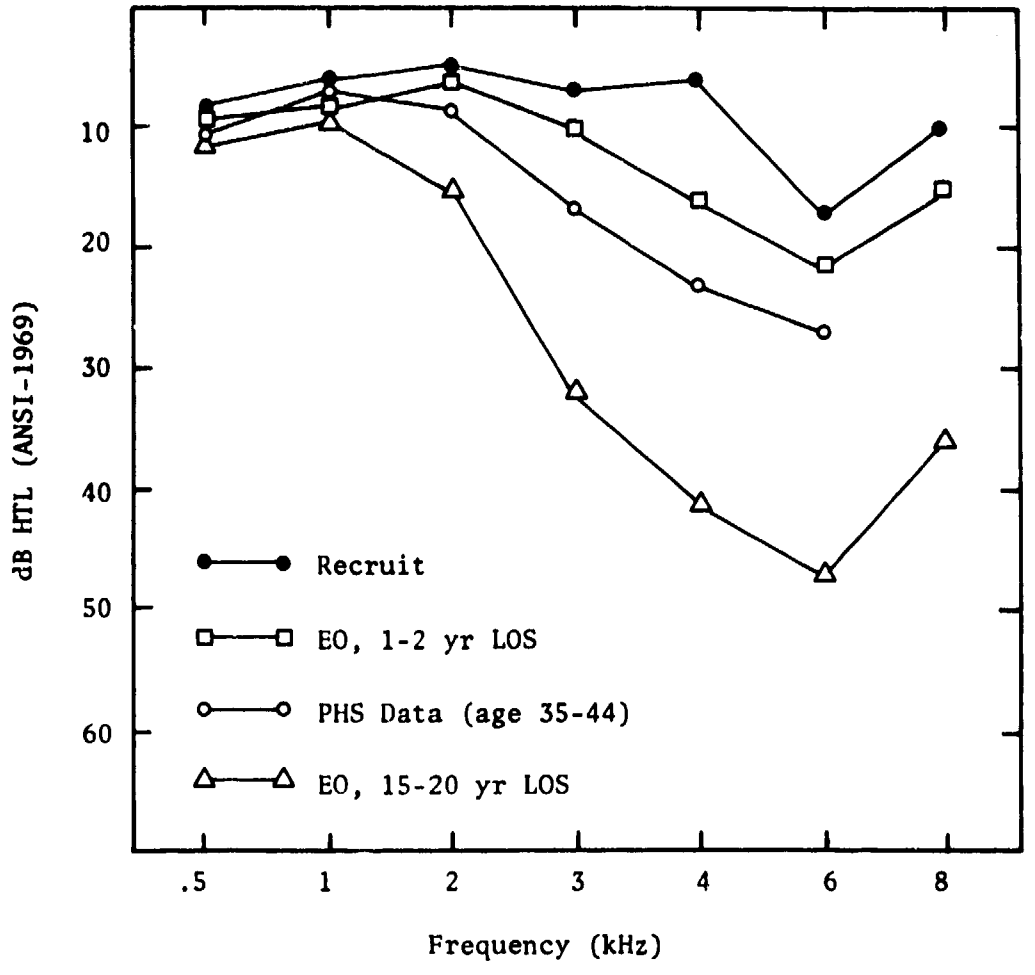


Figure 3

Hearing threshold levels for equipment operators (EO) in 1-2 year and 15-20 year LOS categories. Recruit and PHS data are shown for comparison.

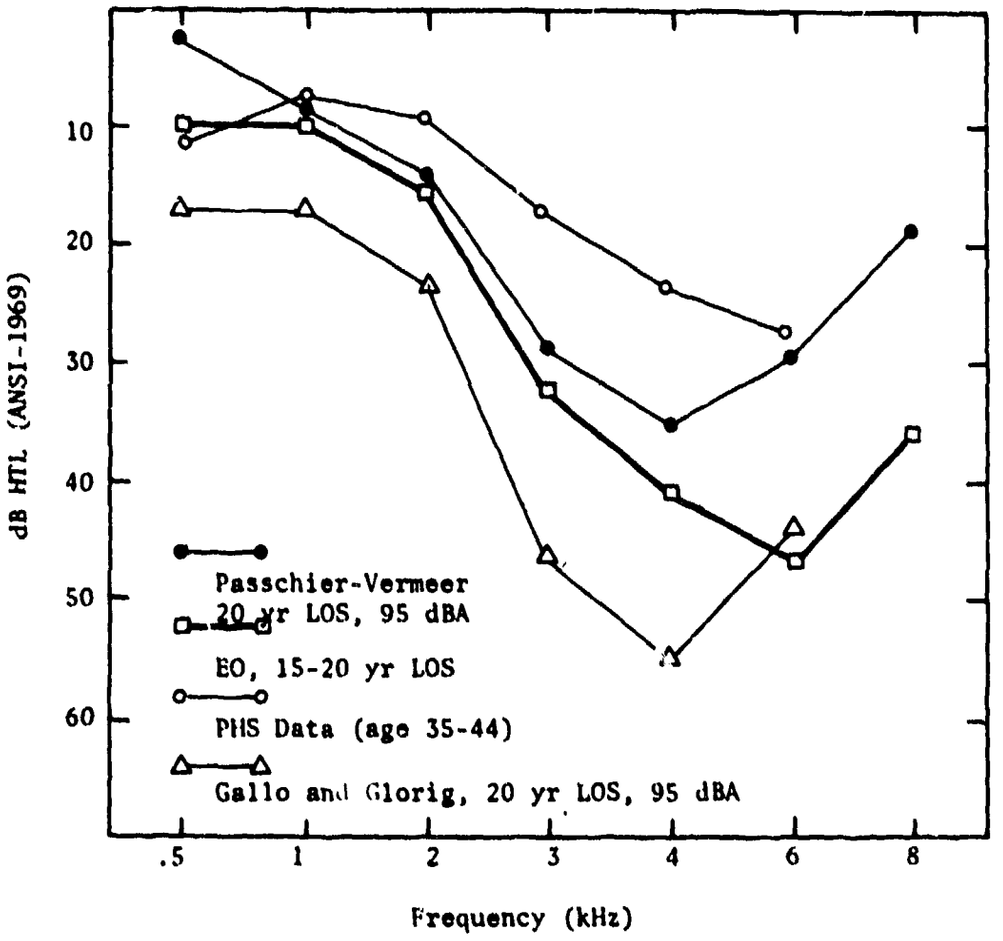


Figure 4

Hearing threshold levels of two private sector industrial populations compared to the navy equipment operator (EO) and PHS data.

4000, and 6000 Hz) is considered, hearing levels for the Navy equipment operators lie exactly between the findings of the two other studies. The Gallo and Glorig study yielded the poorest hearing levels, while the high frequency average in the Passchier-Vermeer study barely met the present study's 30 dB criterion for a significant high frequency hearing loss. Caution should be used in comparing the data in Figure 4 as the variables involved in the studies are manifold. It is interesting to note that Air Force data (10) on over 13,000 noise exposed military and civilian personnel in the age range in question reveal better hearing than that reported in the PHS survey. The authors of the Air Force study attribute this finding primarily to the comprehensive hearing conservation program of the Air Force and, to a lesser extent, the entry standards for Air Force personnel.

Figure 5 shows the recruit and PHS data again, this time compared with the fireman (FN) experimental group apprentice rate data for the 0-1 and 3-4 year LOS categories. Three things are demonstrated here: First, note the divergence between the recruit data and the 0-1 year FN data. Hearing levels apparently change very rapidly for this group after their recruit training. Second, there is no significant difference between the 0-1 and 3-4 year LOS categories. After the initial relatively rapid decrease in hearing sensitivity, hearing apparently is fairly stable over the first enlistment period. Third, the PHS data for the 35-44-year old group correspond almost perfectly in the 2-6 kHz range with those from FN subjects whose average age range is only 19-22 years. In other words, the hearing sensitivity of the Navy's average 20-year old FN appears comparable to that of a typical 40-year old male in the general population.

Figure 6 shows the control group rating (i.e., hospitalmen) with the largest shift in hearing over time. Again recruit and PHS data are shown for comparison. The hearing threshold levels for the hospitalmen are not much better than threshold levels for EOs in the 15-20 year LOS group shown in Figure 3. One possible explanation for this is that 84 percent of the HM in the 20-25 year LOS category served in combat areas in Vietnam where opportunity for increased noise exposure was heightened. Duty tours ranged from 8 to 46 months, with an average tour of 17 months. Additional graphic data covering the same parameters as in Figures 3-6 are shown in Appendix C for all other ratings and apprenticeships.

Half of the control group ratings in the longest duration LOS category demonstrated about the same hearing levels as the 35-44 year PHS data. The remaining control group ratings showed poorer hearing than the PHS data. All experimental group ratings in the longest duration LOS category demonstrated poorer hearing when compared to the PHS findings.

Figure 7 shows the percentage of subjects (pooled across ratings) having significant high-* and low-frequency hearing losses by length of service. The increase in significant high frequency hearing loss over time

- - - - - - - - - - -

*A significant high frequency loss is defined as an average hearing threshold level at 3, 4, and 6 kHz of 30 dB or greater. Thirty dB was chosen because, in general, some difficulty with speech discrimination in noise would be expected with this degree of impairment.

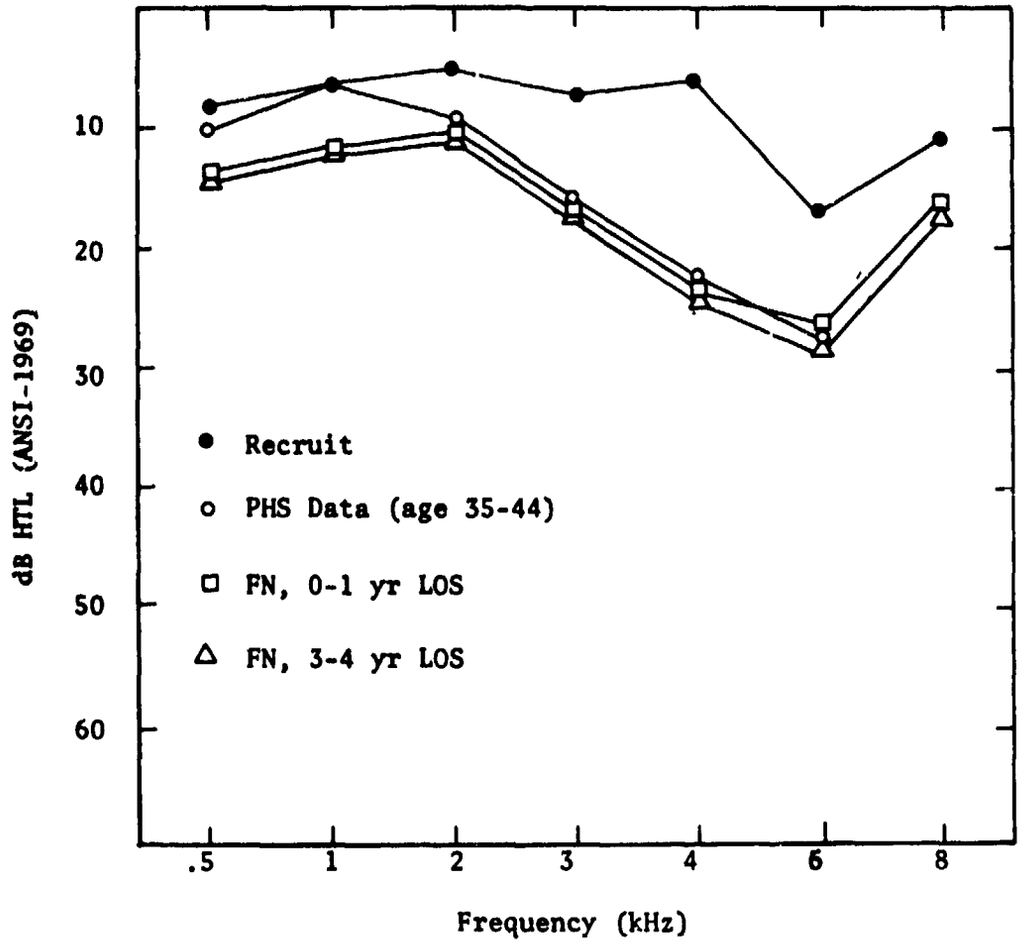


Figure 5

Hearing threshold levels for firemen (FN) in 0-1 year and 3-4 year LOS categories. Recruit and PHS data are shown for comparison.

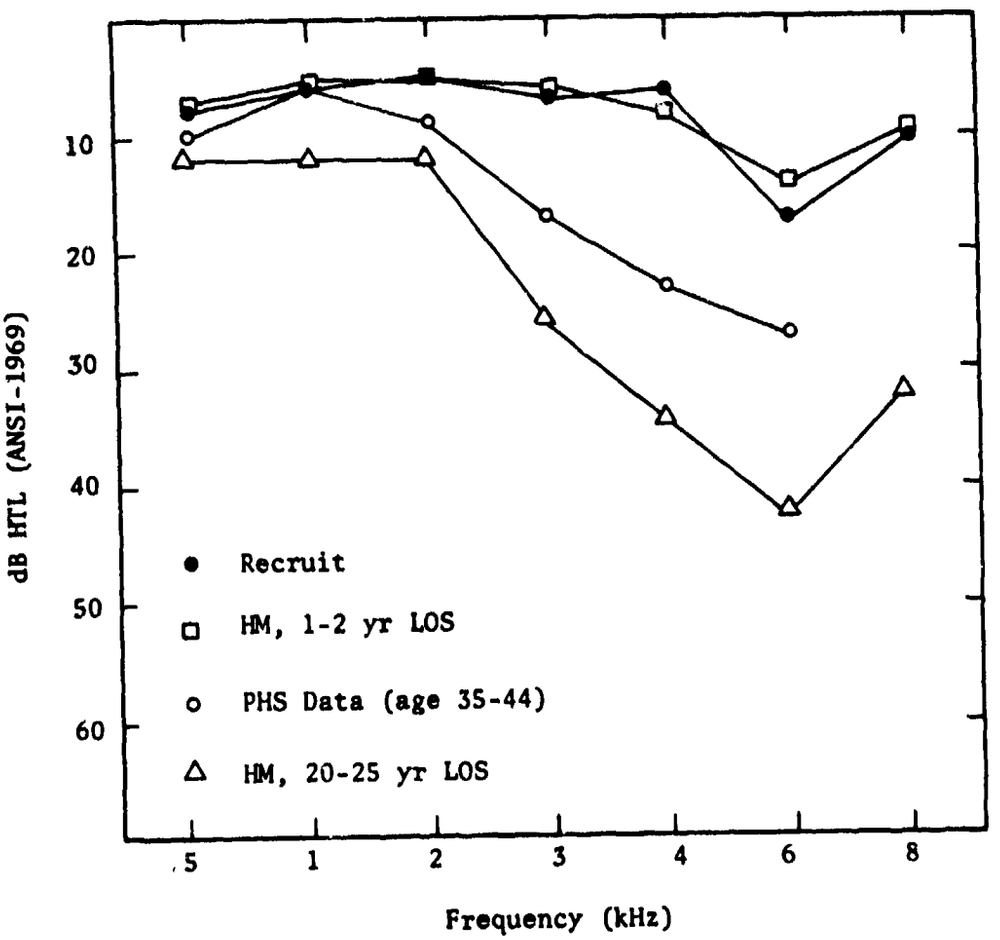


Figure 6

Hearing threshold levels for hospitalmen (HM) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison.

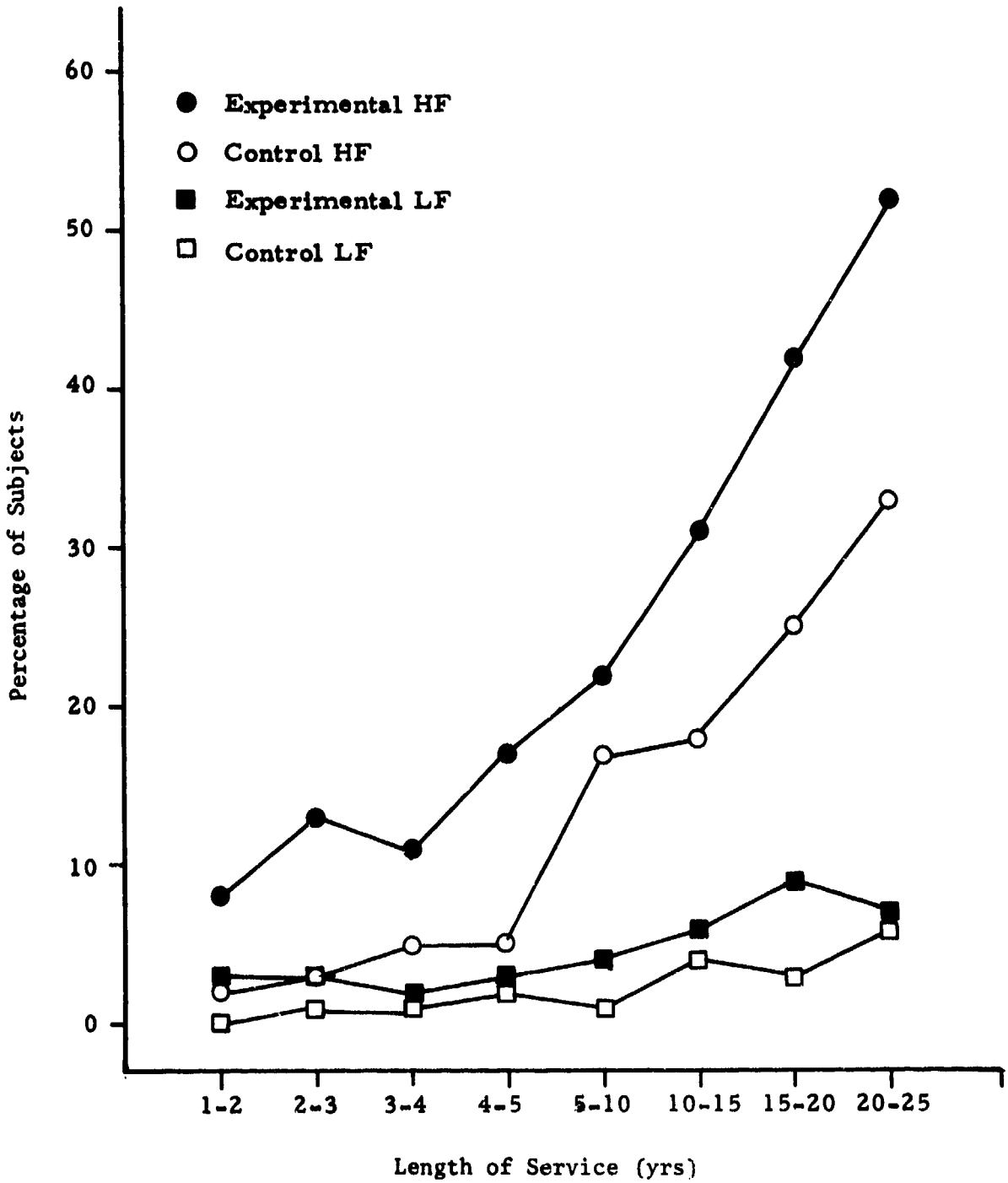


Figure 7

Percentage of subjects with high frequency (HF) and low frequency (LF) hearing loss by length of service.

is evident in both the experimental and control groups. However, there is an obvious separation between the experimental and control groups for this parameter. For the 20-25 year LOS category there is nearly a 20 percent greater proportion of high frequency loss for the experimental group than for the control group. The 17-33 percent range of high frequency loss in the control group from five years onward should also be recognized as significant. Appendix D contains detailed graphic data on significant high frequency losses where the percentage of every LOS category by individual ratings for both the experimental and control groups is presented. It should be noted that for both the EO and MM ratings, the percentage of subjects with significant high frequency loss exceeds 60 percent for both the 15-20 and 20-25 year LOS categories (Figures D-3, D-4).

Low frequency losses* rose very slowly and were similar for both the experimental and control groups. The percentage of subjects involved ranged from zero to about 9 percent. It is characteristic of noise induced hearing loss that low frequency impairment is much less than high frequency loss, and the progression over time is slower for low frequency hearing impairment. Detailed graphic data on significant low frequency hearing losses are shown in Appendix E, where percentages are shown by LOS category for each rating in both experimental and control groups.

Table II shows data from the Abramson and Goldenberg (1) Marine Corps study of 1974. The percentages indicate the proportion of subjects having a significant high frequency loss (as defined previously) for a particular MOS (military occupational specialty) and LOS. These data are in agreement with data from the present study and from the Army study in that they show, in all but two instances (MOS 60 and 25), a progressively greater prevalence of high frequency hearing loss as LOS increases. Also, note the very high percentage (56-79) of personnel in the "11 years and over" category that have significant high frequency losses. Of all the ratings studied in the present investigation, only Navy EOs with comparable LOS would fall within the lowest ranges shown for Marine Corps personnel.

Table III presents a comparison among three aircraft maintenance job categories. The Navy AM and AD ratings compare most closely with the Marine MOS 60. Note that in all LOS categories, the percentage of Navy personnel with significant high frequency losses is dramatically less than for the Marine Corps personnel. The reason for these large differences would be worthy of investigation.

In comparing the present experimental group findings (Figure 7) to the Marine Corps high frequency loss data shown in Table II, an interesting trend emerges. For the LOS categories up through ten years, the percentage of subjects demonstrating significant high frequency loss is about 2 1/2

- - - - - - - - - - -

*A significant low frequency loss is defined as an average hearing threshold level of 25 dB or greater for the frequencies 500, 1000, and 2000 Hz. Twenty-five dB was chosen because, in general, difficulty with faint speech begins at about this level.

Table II

Marine Corps Study:

Percentage of Subjects Showing Significant High Frequency Hearing Loss*

MOS		N	Length of Service (yrs)				Overall Percent Average
			0-2	3-4	5-10	11+	
08	Artillery	744	25	42	65	72	51
18	Tank & Amphib.	554	27	47	50	67	48
21	Armament Rep.	178	27	38	42	79	47
60	Aircraft Maint.	159	35	24	50	75	46
03	Infantry	1081	22	36	48	71	44
35	Motor Transpt.	767	22	30	50	70	43
13	Engineers	495	25	31	40	70	42
25	Oper. Comm.	652	22	27	57	56	40
61	Aircraft Maint. (Helo)	611	20	24	31	61	34

*From reference (1).

Table III

Percentage of Subjects Among Aircraft Maintenance Personnel Demonstrating Significant High Frequency Loss

MOS/Rating	Length of Service (yrs)				Overall Percent Average
	0-2	3-4	5-10	11+	
60 (USMC)*	35	24	50	75	46
AM (Navy)	6	14	20	32	18
AD (Navy)	2	2	12	35	13

*From reference (1).

times greater for the Marine Corps personnel. For the LOS categories over ten years, the proportion of high frequency hearing loss for Marine Corps personnel is about 1 1/2 times greater than for personnel in the Navy ratings studied. Since there is no evidence that the Marine Corps hearing conservation programs are any less effective than those in the Navy, this finding would support the premise that Marines are subjected to greater noise exposure than are naval personnel.

Although the Army's profiling system prevents the majority of the Army data from being directly compared with the present findings, an interesting comparison can be made from data shown in Figure 8. Data for the Navy experimental group in the 15- to 20-year LOS category (averaged across ratings) are presented with the Army data (12) for various time-in-service categories. It is interesting to note that hearing levels for Navy personnel in the 15- to 20-year LOS category are almost identical to hearing levels for Army personnel in the 7.5- to 12.4-year time-in-service category. This would suggest that compared to Navy personnel, Army personnel experience greater noise exposures and sustain hearing losses more quickly.

Figure 9 presents the percentage of subjects with significant high and low frequency hearing losses by rating, averaged across LOS categories. The percentages are arranged in ascending order for the recruits, the four apprentice groups, and the 16 ratings. Note that the experimental and control groups show a continuum of percentage values, with the control group showing consistently less high-frequency hearing loss than the experimental group. Note the relatively high percentage shown for the FN group. This apprenticeship channels into the EN, BT, and MM ratings, which all show some of the largest percentage of high frequency losses observed in the study. Note that some ratings are very similar in the two groups; for example, the findings for the AO, AD, AZ, and DK ratings.

Basic data from the present investigation are shown in Appendix F. Tables F-1 through F-21 present average hearing threshold levels for each LOS category by ear and frequency for each rating and apprenticeship. The number of subjects in each LOS category, the average age of personnel in each LOS category, and the standard deviations of the average hearing threshold levels are also shown. The tables appear in the same order as the ratings and apprenticeships in Figure 9.

Only the results of the present study for the EO ratings at 36 percent (Figure 9) fit into the overall average range of the Marine Corps data (see Table II). Even considering the numerous differences between the present study and the Marine Corps study, it is apparent that the prevalence of high frequency hearing loss is considerably greater in the Marine Corps MOSs examined than in the Navy ratings studied.

The hatched portions of Figure 9 show the percentages for significant low frequency loss. There is a good deal more overlap between the experimental and control groups for the low frequency than for the high frequency parameter. This is to be expected since noise induced hearing loss does not affect the speech frequencies (500-2000 Hz) unless the loss is very severe. The low frequency average is a good estimate of the speech

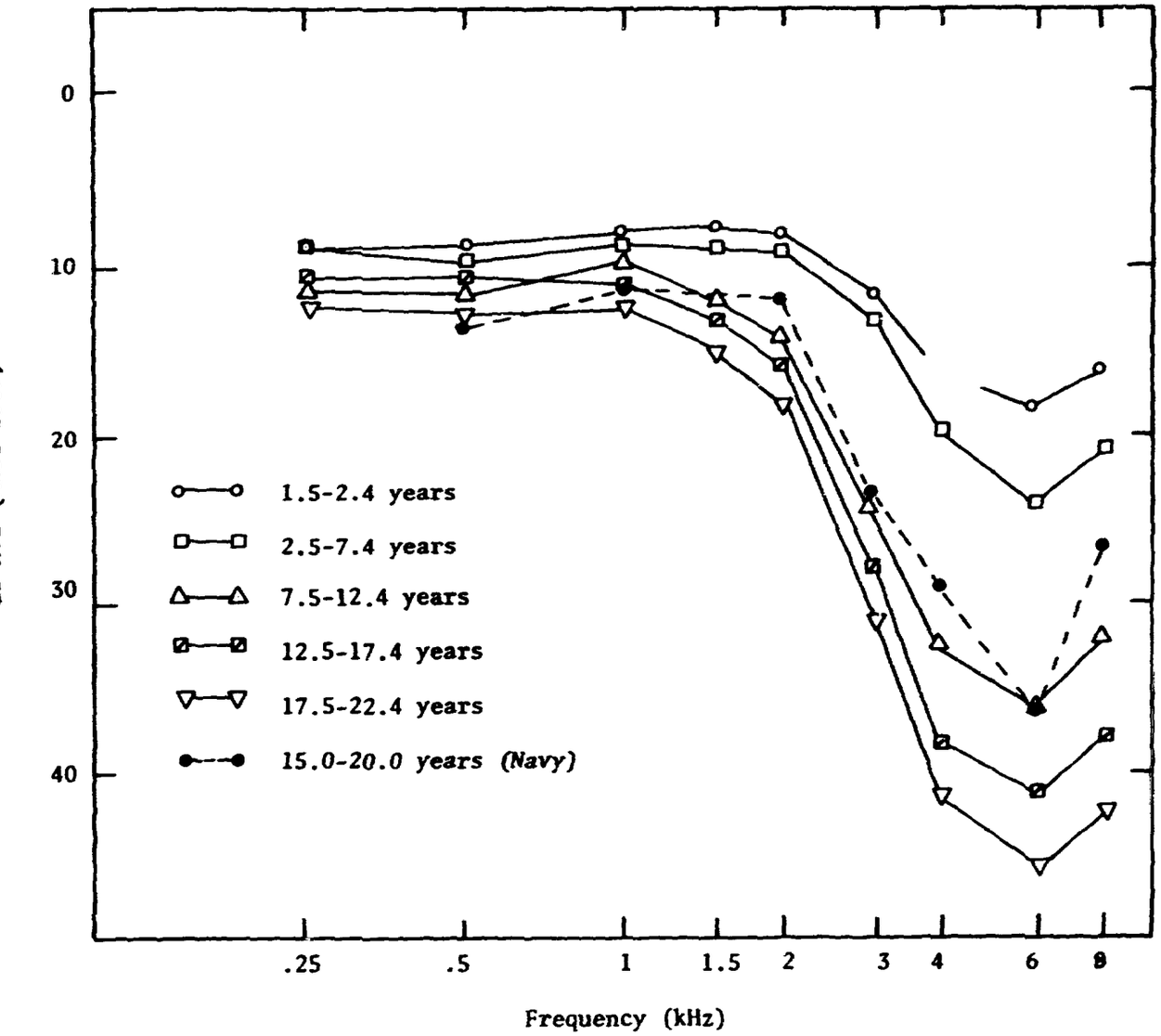


Figure 8

Navy experimental group findings for the 15-20 year LOS category (n=200) compared with the Army data for various time-in-service categories.

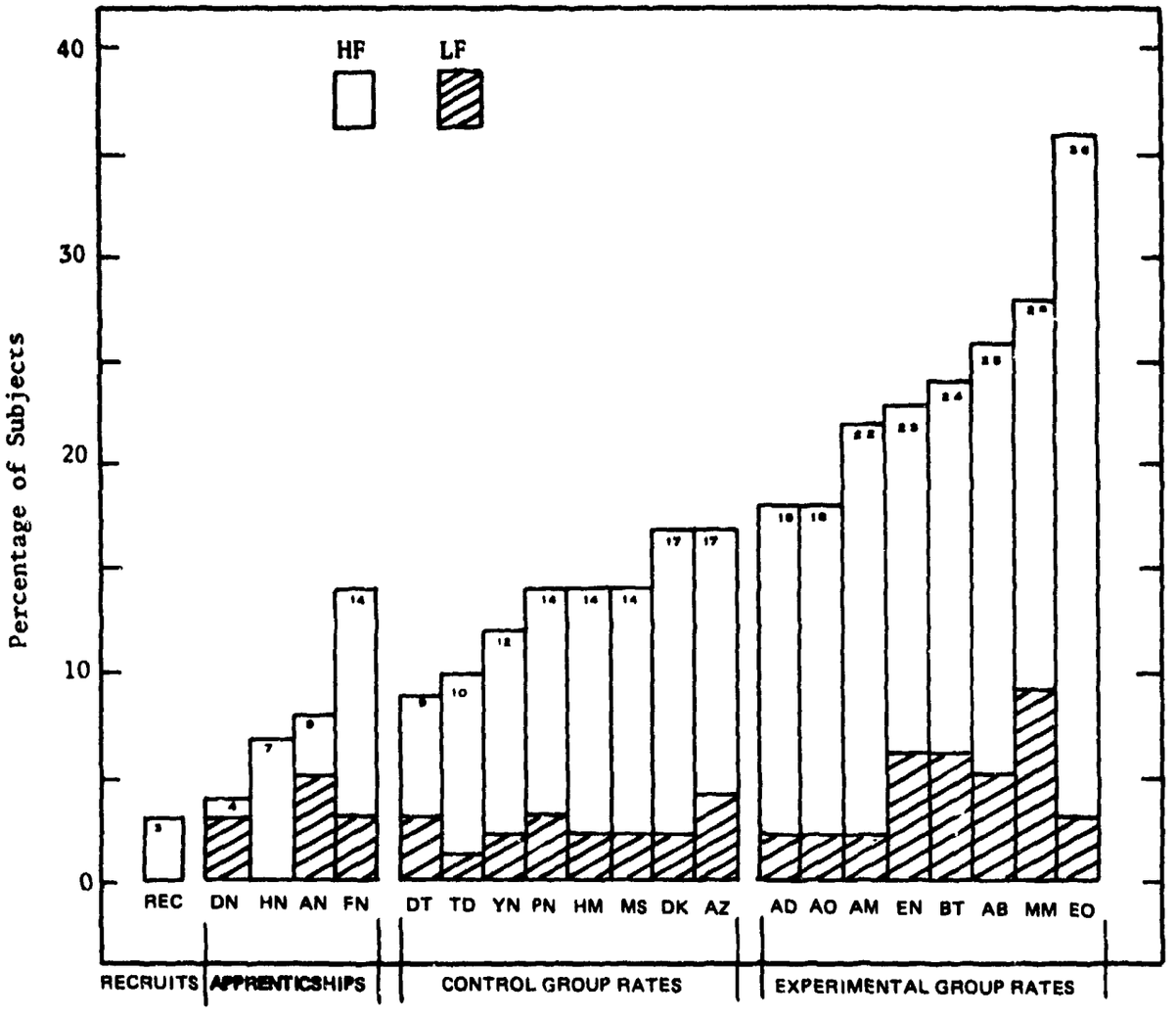


Figure 9

Percentage of subjects with significant high (HF) and low frequency (LF) hearing loss by rating.

reception threshold (SRT). The present findings for the prevalence of low frequency loss (3 percent overall) are consistent with the Army finding that "SRTs were relatively normal for the vast majority of the 3000 subjects" (12).

The prevalence of significant low frequency loss is not to be ignored. However, it is clear that the major problem is the substantial prevalence of high frequency losses, not only in the experimental group but in the control group as well.

To get some idea of the potential number of naval personnel having significant high frequency hearing losses and for an overview of the percentages of personnel affected in the experimental and control groups, the data in Table IV are presented. In the control group approximately 8000 personnel could be affected. This represents one of every fourteen in the apprenticeships and one of every eight in the eight ratings examined. In the experimental group approximately 23,000 personnel could be involved. This represents one of every nine in the apprenticeships and one of every four in the eight ratings studied. Estimates of the number of personnel affected by rating are shown in Appendix G.

Shown on the questionnaire in Appendix B are the overall percentages of affirmative responses for both the experimental and control groups on six selected items thought to be most related to the hearing test results. The other items in the questionnaire were not tabulated in this fashion. Presentation and discussion of the questionnaire data are given in Appendix H.

In the present investigation attention was given to about 20 percent of the approximately 80 ratings in the Navy. Considering this, it is clear that the total number of personnel exhibiting significant hearing loss is indeed formidable.

CONCLUSIONS

The data obtained in this study support the presentation of the following conclusions:

1) Navy recruits demonstrate hearing levels comparable to hearing levels of Army and Air Force recruits except at 6000 Hz where some variability is observed.

2) Thirty-seven percent of the experimental group and 23 percent of the control group demonstrated a significant high frequency loss beyond 4 to 5 years of service.

3) The Equipment Operator rating displayed the highest percentage of high frequency hearing loss of any rating studied.

4) The prevalence of low-frequency hearing loss was relatively low (4 to 7 percent) and was more pronounced for the experimental group ratings.

Table IV

Estimated Number of Personnel with Significant
High Frequency Hearing Loss

	Experimental				Control		
	Current On-Board Pop.	Percentage of Sample	Estimated Number		Current On-Board Pop.	Percentage of Sample	Estimated Number
Apprent.	34,366	11%	3,756	Apprent.	5,634	7%	372
Ratings	83,088	24%	19,778	Ratings	59,187	14%	8,044
	117,490		23,534		64,821		8,416

5) Personnel in all of the experimental group ratings and in one half of the control group ratings demonstrated poorer hearing than comparable aged adult males for whom data were obtained in the 1960-62 Public Health Survey (7).

6) The problem of hearing loss is more widespread than was originally thought. In many instances, the hearing threshold levels of subjects in the control group ratings approached hearing levels of individuals in the experimental group ratings. Overall, one of every eight subjects in the control group ratings (estimated 8000 personnel) and one of every four subjects in the experimental group ratings (estimated 23,000 personnel) had a significant high frequency hearing loss. The significant decline in hearing over time for both groups cannot be accounted for simply on the basis of aging.

These findings indicate that a vital sensory function of naval personnel is being degraded or lost. Loss of hearing has a tremendous impact not only on the individual and his family, but, in aggregate, also upon the operational readiness and efficiency of the U.S. Navy.

RECOMMENDATIONS

1) The immediate and full implementation of naval hearing conservation programs is imperative. More attention must be paid to ratings that have been assumed in the past to be insufficiently noise exposed to be of concern.

2) A study of the prevalence of hearing loss among the various construction battalion ratings should be undertaken.

3) More accurate and more efficient ways are needed to conduct monitoring audiometry. It is strongly recommended that a computer based data acquisition, storage, and retrieval system be developed for use in naval hearing conservation programs. This would include the utilization of microprocessor controlled audiometers, a data bank, and an efficient data base management system. If such a system had existed, the data for the present survey could have been accumulated in a matter of hours as opposed to the nearly three years actually taken. Another major advantage of such a system would be the capability of ongoing day-by-day management assessment of hearing conservation program effectiveness from both central and regional levels.

REFERENCES

1. Abramson, A. L., and Goldenberg, R. A., Hearing survey of Marine Corps personnel at Camp Lejeune, North Carolina. Unpublished preliminary report, Camp Lejeune, N.C., 1974.

2. American National Standards Institute: American National Standard Specifications for Audiometers. ANSI S3.6-1969. New York, 1969.

3. Department of Defense, DODINST 6055.3. Hearing Conservation, Washington, D.C., 8 June 1978.

4. Department of the Navy, Bureau of Medicine and Surgery. BUMEDINST 6260.6B. Hearing Conservation Program. Washington, D.C., 5 Mar 1970.

5. Gallo, R., and Glorig, A., Permanent threshold shift changes produced by noise exposure and aging. Amer. Ind. Hyg. Assoc. J., 25:237-245, 1964.

6. International Organization for Standardization, Recommendation R226. Normal equal loudness contours for pure tones and normal threshold of hearing under free-field listening conditions. Geneva, 1961.

7. National Center for Health Statistics. Hearing levels of adults by age and sex, U.S. 1960-62. Vital and Health Statistics. PHS Pub. No. 1000, Series 11, No. 11. Public Health Service. Washington D.C.: U.S. Government Printing Office, October 1965.

8. Passchier-Vermeer, W., Presbycusis data, In: Guignard, J. C. (Ed.), A basis for limiting noise exposures for hearing conservation. AMRL-TR-73-90, Appendix 3, Wright-Patterson AFB, Ohio, 1973.

9. Schneider, E. J., Mutchler, J. E., Hoyle, H. R., Ode, E. H., and Holder, B. B., The progression of hearing loss from industrial noise exposure. Amer. Ind. Hyg. Assoc. J., 31: 368-376, 1970.

10. Sutherland, H. C., and Gasaway, D. C., Hearing levels of noise-exposed U.S. Air Force personnel compared to those in the total U.S. population. SAM-TR-76-27. Brooks Air Force Base: School of Aerospace Medicine, 1976.

11. Sutherland, H. D., Gasaway, D. C., and Boyer, J. F., Jr., Hearing of young airmen entering noise exposure career fields. SAM-TR-71-36. Brooks Air Force Base: School of Aerospace Medicine, 1971.

12. Walden, B. E., Prosek, R. A., and Worthington, D. W., The prevalence of hearing loss within selected U.S. Army branches. IAO 4745, U.S. Army Medical Research and Development Command, Washington, D.C.: August 1975.

APPENDIX A

Distribution of Female Subjects by Rating

Experimental				Control			
Sample N	Rating	Number Females	% of Sample	Sample N	Rating	Number Females	% of Sample
100	AN	23	23.0	200	YN	59	29.5
191	EN	3	1.5	198	PN	42	21.0
100	FN	1	1.0	181	DT	34	19.0
200	AM	1	0.5	170	AZ	29	17.0
189	AO	1	0.5	96	HN	28	29.0
200	AD	-	-	200	HM	21	10.5
200	BT	-	-	168	DK	19	11.0
200	AB	-	-	175	TD	18	10.0
200	MM	-	-	65	DN	15	23.0
177	EO	-	-	199	MS	4	2.0
1757	TOTAL	29	1.7	1652	TOTAL	269	16.0

APPENDIX B

LOS: _____
RATE: _____

QUESTIONNAIRE

STUDY OF INCIDENCE OF HEARING LOSS BY NAVY RATE

NAME _____ RATE _____ SERIAL NO. _____

DATE _____ AGE ___ SEX _____ DOB _____

LENGTH OF SERVICE _____ PRESENT ACTIVITY _____

MEDICAL HISTORY:

DO YOU NOW OR HAVE YOU HAD ANY OF THE FOLLOWING:

YES	NO		COMMENTS	% Yes Experimental	% Yes Control
☐	☐	A. SINUS OR ALLERGY			
☐	☐	B. DIZZINESS			
☐	☐	C. SERIOUS ILLNESS			
☐	☐	D. SURGERY			
☐	☐	E. SEVERE BLOW TO THE HEAD			
☐	☐	F. HEAD NOISES	Rates:	10	7
			Apprent:	10	8
☐	☐	G. EARACHES AND/OR DRAINING EARS			
☐	☐	H. MEDICATION			
☐	☐	I. DO YOU THINK YOU HAVE NORMAL HEARING?	Rates:	76	86
			Apprent:	78	82
☐	☐	J. DO YOU HAVE PROBLEMS UNDERSTANDING SPEECH IN ANY SITUATION?	Rates:	22	14
			Apprent:	27	23

YES	NO				
☐	☐	1.) PRIOR TO MILITARY SERVICE DID YOU WORK IN JOBS, EITHER PART TIME OR FULL TIME, IN WHICH THE NOISE LEVELS WERE SUCH THAT YOU HAD TO RAISE YOUR VOICE TO BE UNDERSTOOD?	Rates:	23	18
			Apprent:	32	29

IF YES, LIST THOSE JOBS AND NUMBER OF MONTHS IN WHICH YOU WERE EMPLOYED. START WITH THE MOST RECENT.

TYPE OF JOB	PLACE OF EMPLOYMENT	MONTHS OF EMPLOYMENT	SOURCE OF NOISE	DID YOU USE EAR PROTECTION

LIST ALL MILITARY ASSIGNMENTS (INCLUDING SCHOOLS)

JOB	ACTIVITY	UNIT	HOW LONG

YES ☐ NO ☐ 2.) HAVE YOU EVER BEEN IN COMBAT?

	% Yes Experimental	% Yes Control
Rates:	16	13
Apprent:	1.5	00

IF YES:

A. HOW MANY MONTHS _____

B. DID YOU FIRE WEAPONS FOR MORE THAN 100 DAYS? _____

C. DESCRIBE TYPES OF WEAPONS FIRES? INDIVIDUAL CREW BOTH _____

D. LIST SPECIFIC ASSIGNMENTS:

	EAR PROTECTION		
_____	YES	NO	SOMETIMES
_____	YES	NO	SOMETIMES
_____	YES	NO	SOMETIMES

YES NO 3.) DO YOU NOW OR HAVE YOU IN THE PAST PARTICIPATED REGULARLY IN ANY OF THE FOLLOWING:

			% Yes Experimental	% Yes Control
☐	☐	A. MEMBER OF A ROCK-AND-ROLL BAND	Rates:	50	40
☐	☐	B. SPORT SHOOTING	Apprent:	52	40
☐	☐	C. AUTO OR DRAG RACING			
☐	☐	D. MOTOR CYCLING			
☐	☐	E. ANY OTHER HOBBY OR OFF-JOB ACTIVITY THAT IS TYPICALLY NOISY OR HAS LOUD SOUNDS ASSOCIATED (e.g. SPORT FLYING, MACHINE WORK, WOODCRAFT, etc.)			

IF YES, LIST WITH EACH ACTIVITY:

a.) NO. OF YEARS _____

b.) NO. OF DAYS PER WEEK TYPICALLY SPENT AT THIS ACTIVITY _____

c.) ON THE DAYS ENGAGED IN ACTIVITY, THE AVERAGE NO. OF HOURS _____

d.) WHEN ENGAGED IN ACTIVITY, DO YOU ROUTINELY WEAR EAR PROTECTION?
YES NO SOMETIMES

WHAT WAS YOUR MOST RECENT EXPOSURE TO LOUD NOISE (SPECIFY, e.g., AIRCRAFT, HOBBY, WORKPLACE, GUNSHOT, etc.) ? _____

_____ _____

HOW LONG DID THIS EXPOSURE LAST? _____

DO YOU HAVE A COLD TODAY? _____

HEARING LEVEL DATA:

	.5K	1K	2K	3K	4K	6K	8K
RT. AC							
RT. BC							
LT. AC							
LT. BC							

DATE _____ LOCATION _____

AUDIOMETER _____ TESTER _____

COMMENTS:

PRIVACY ACT STATEMENT

Under the authority of 5 USC 301, personal data are requested in order that we might identify you if it seems necessary to re-evaluate your hearing at a later time. The information provided by you will become part of NAMRL medical records. The information provided will not be divulged without your written authorization to anyone other than data processing personnel and professional and technical personnel within NAMRL. You are not required to provide this information; however, failure to do so would result in our inability to contact you for re-evaluation if there are any unusual findings in your hearing test data.

APPENDIX C

Hearing threshold levels by frequency are shown for two length-of-service categories for the following ratings and apprenticeships:

Figure C-1	BT
Figure C-2	MM
Figure C-3	AB
Figure C-4	AD
Figure C-5	AO
Figure C-6	EN
Figure C-7	AM
Figure C-8	AN
Figure C-9	DT
Figure C-10	MS
Figure C-11	TD
Figure C-12	YN
Figure C-13	PN
Figure C-14	DK
Figure C-15	AZ
Figure C-16	HN
Figure C-17	DN

Recruit and Public Health Survey data are shown for comparison.

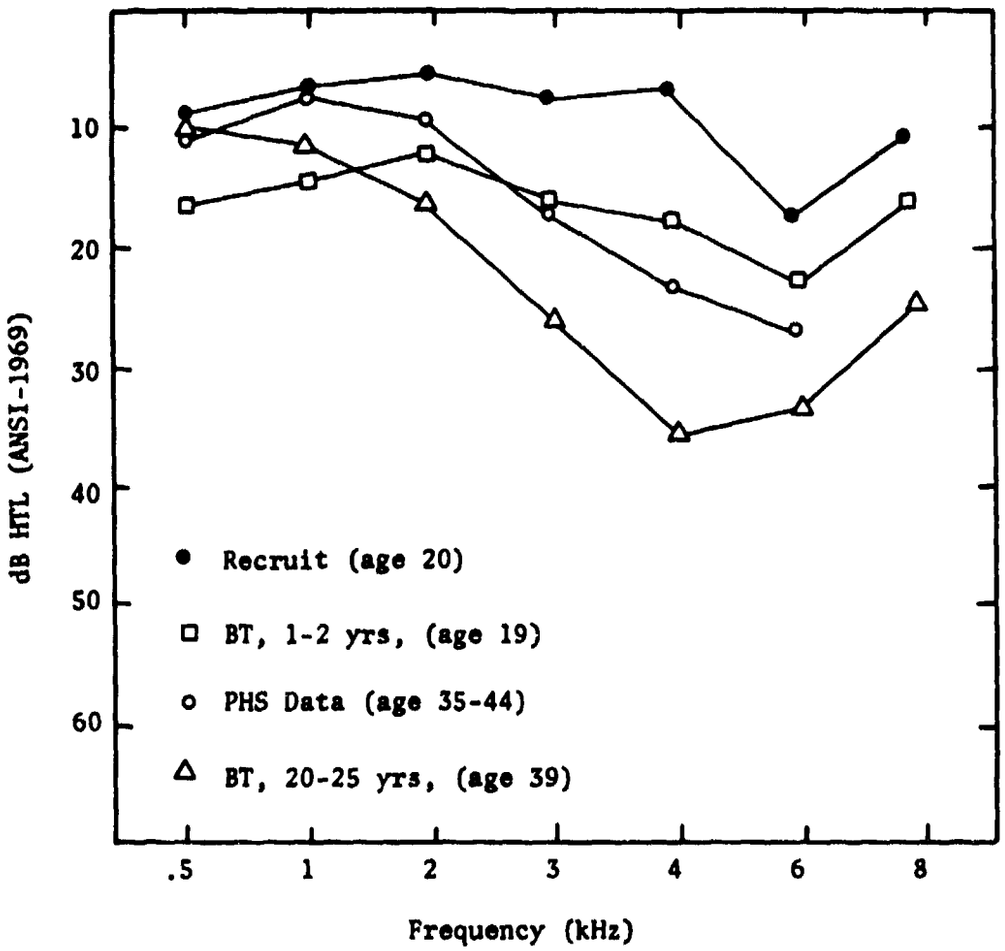


Figure C-1

Hearing threshold levels for boiler technicians (BT) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

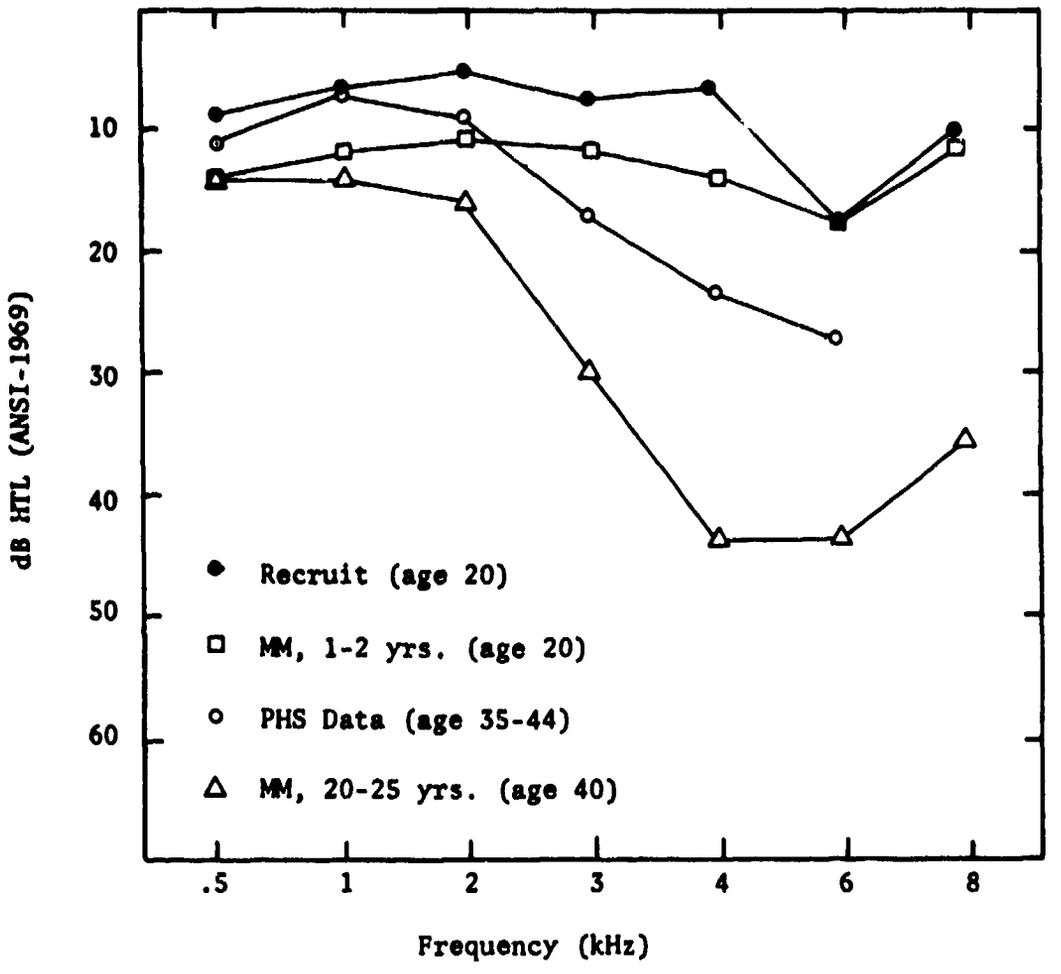


Figure C-2

Hearing threshold levels for machinist mates (MM) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

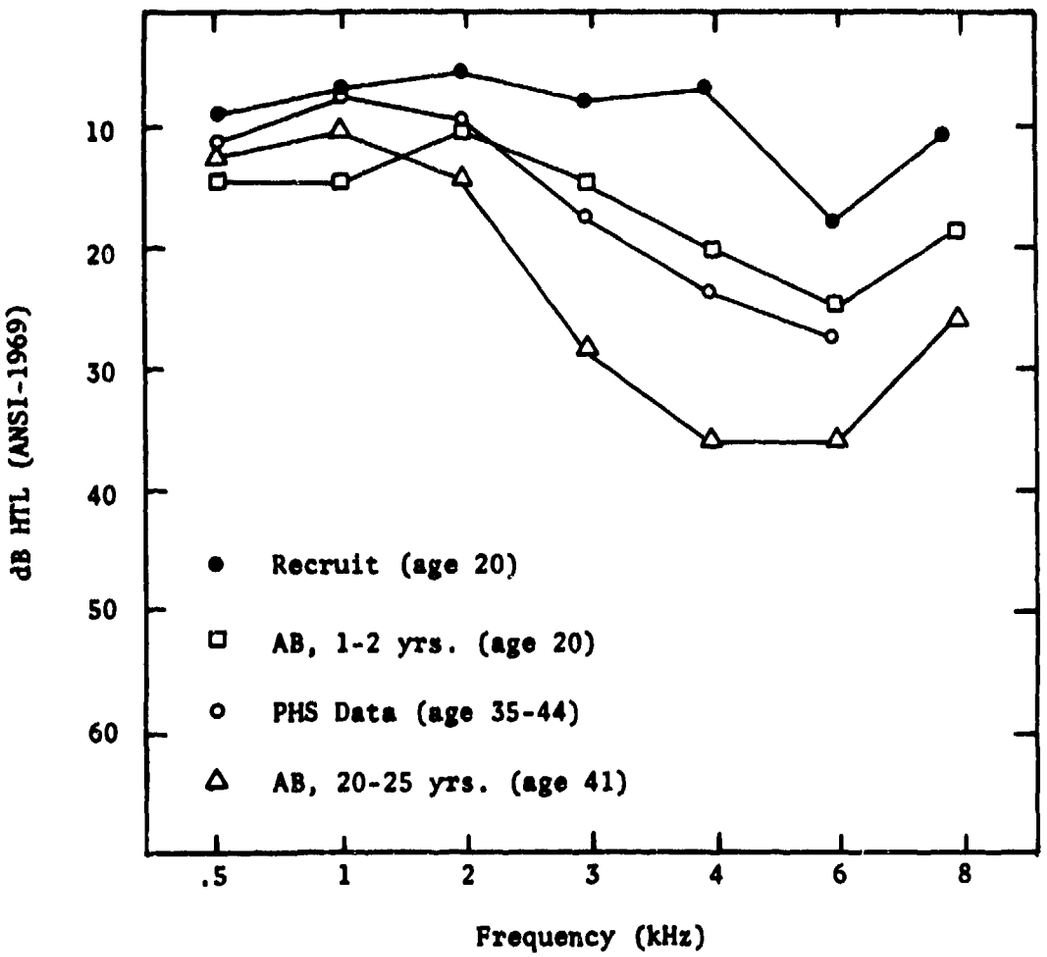


Figure C-3

Hearing threshold levels for aviation boatswain mates (AB) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

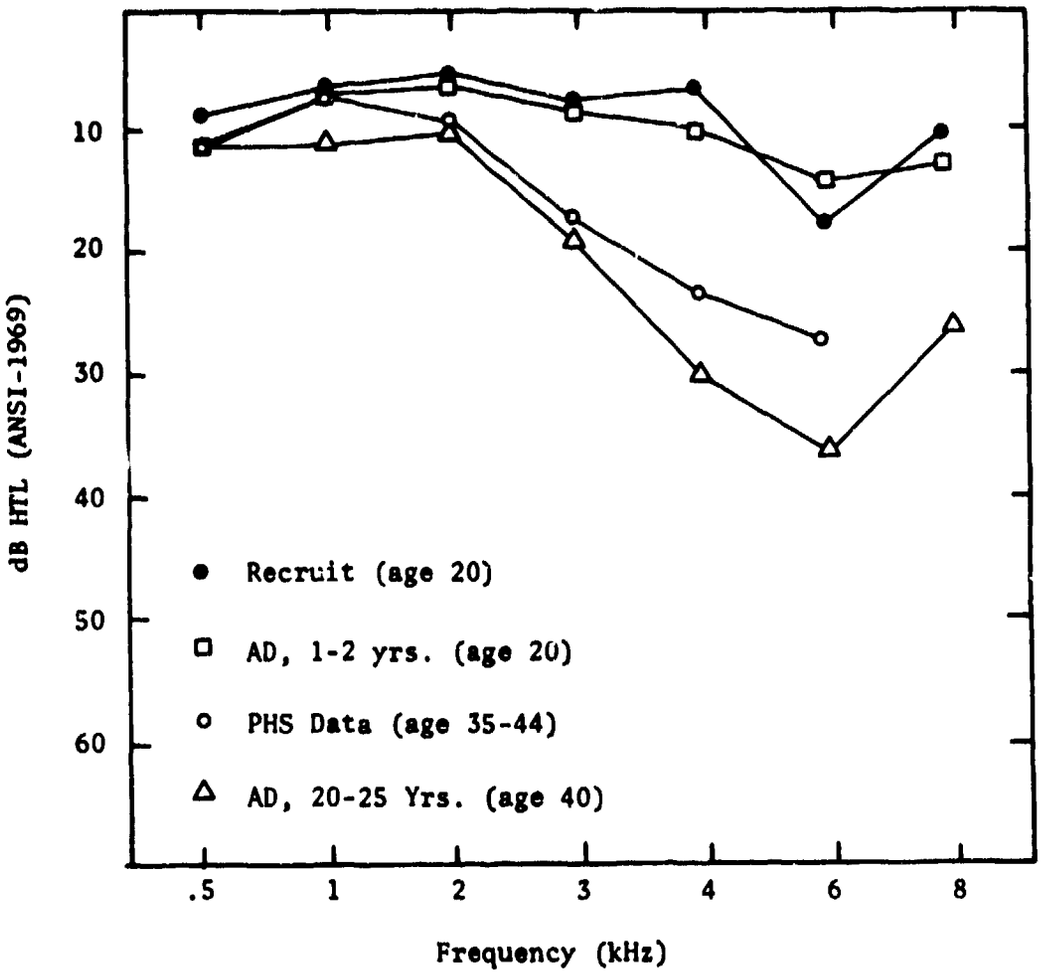


Figure C-4

Hearing threshold levels for aviation machinist mates (AD) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

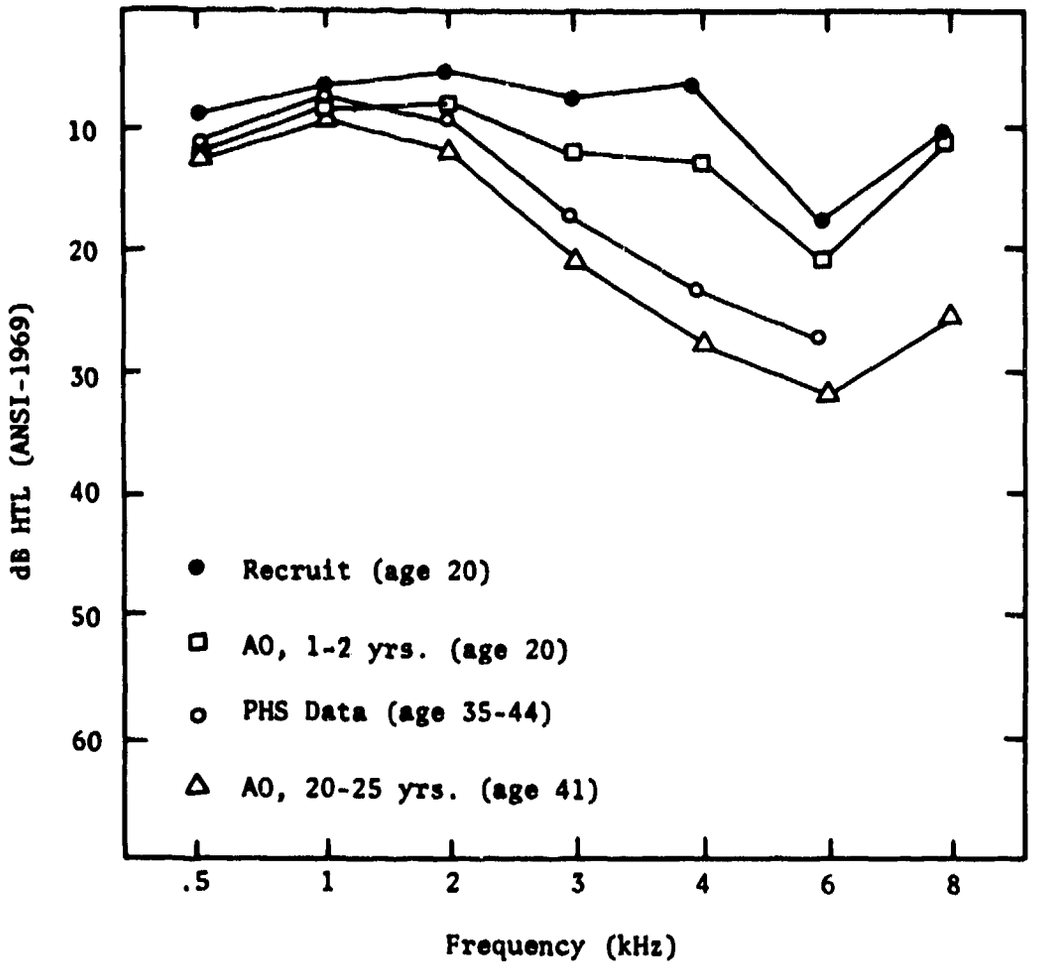


Figure C-5

Hearing threshold levels for aviation ordinancemen (AO) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

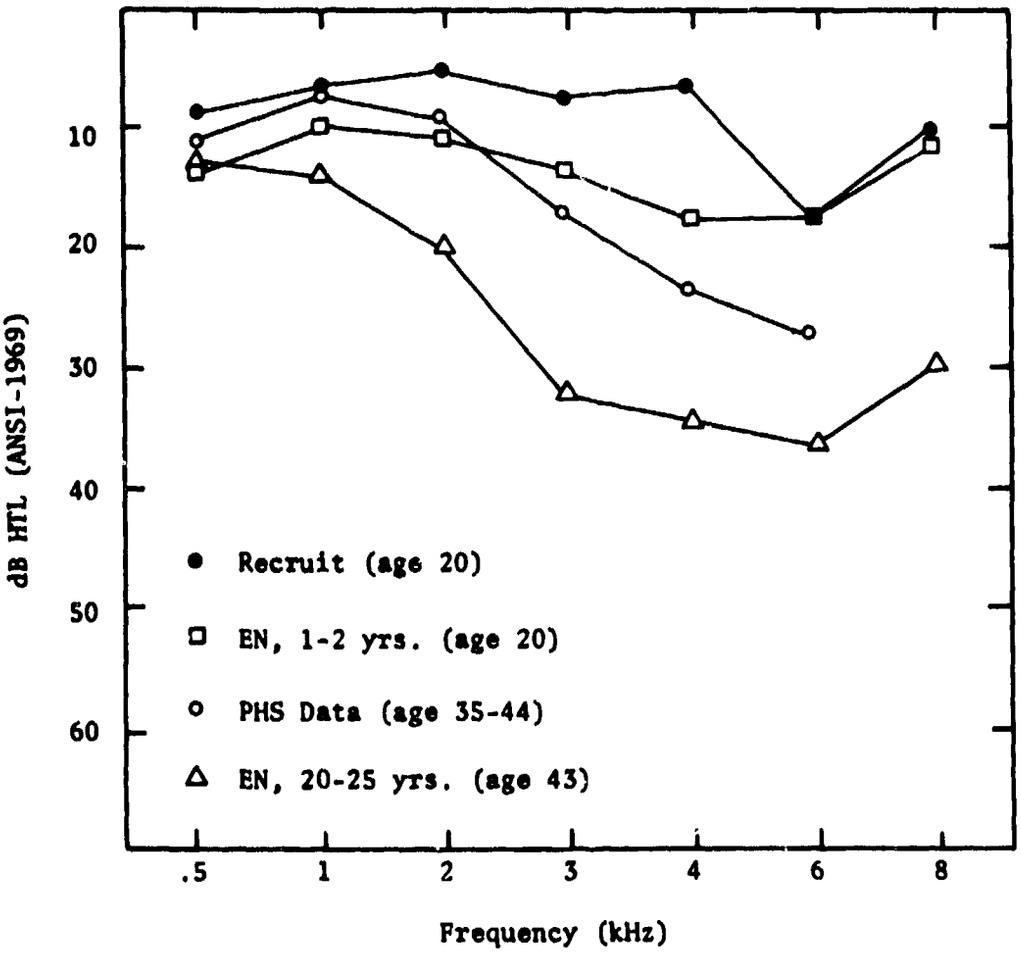


Figure C-6

Hearing threshold levels for enginemen (EN) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

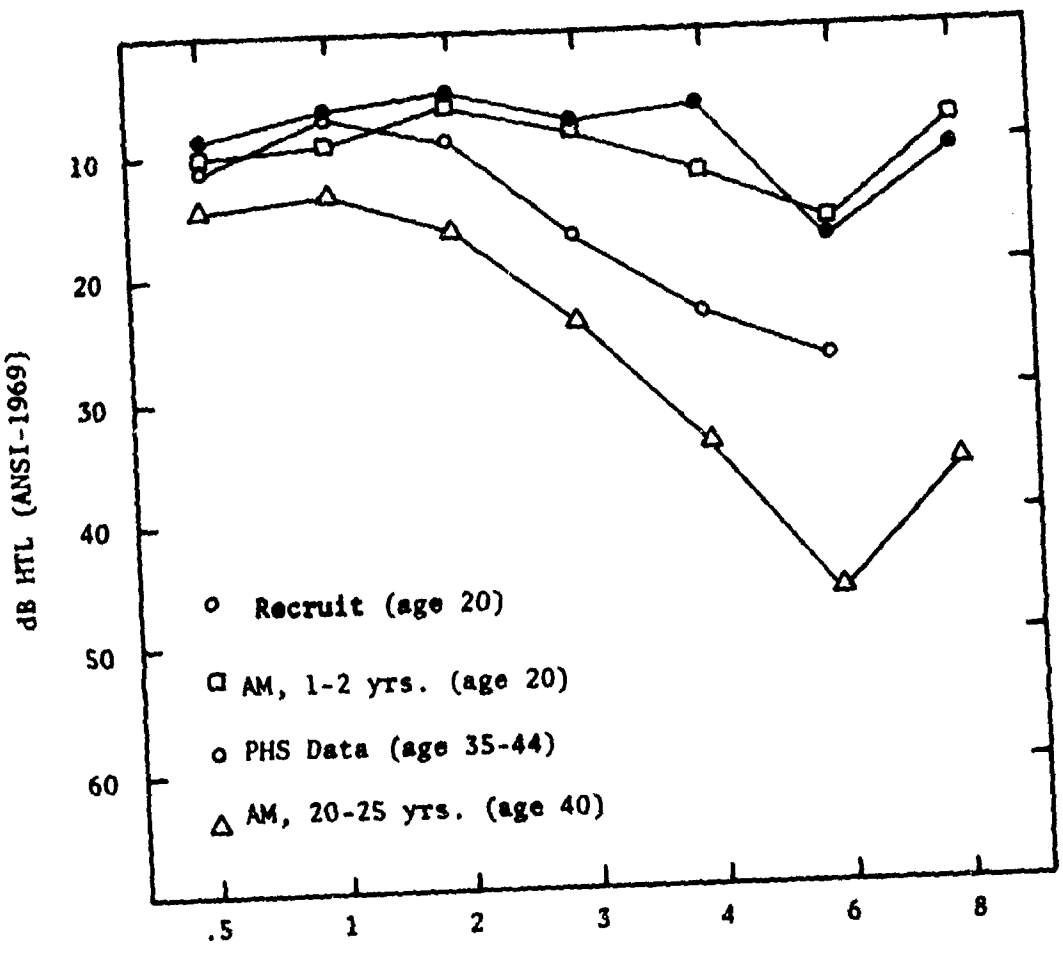


Figure C-7

Hearing threshold levels for aviation mechanics (AM) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

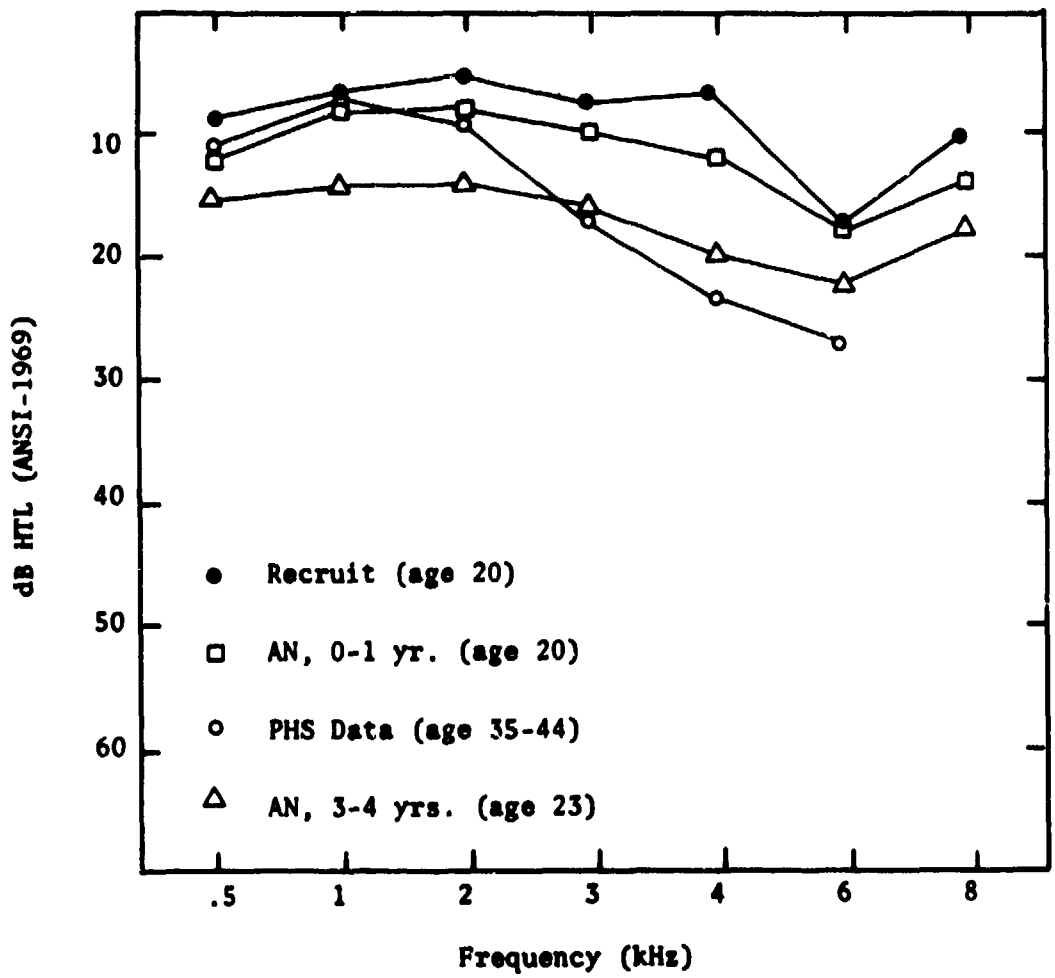


Figure C-8

Hearing threshold levels for airmen (AN) in 0-1 year and 3-4 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

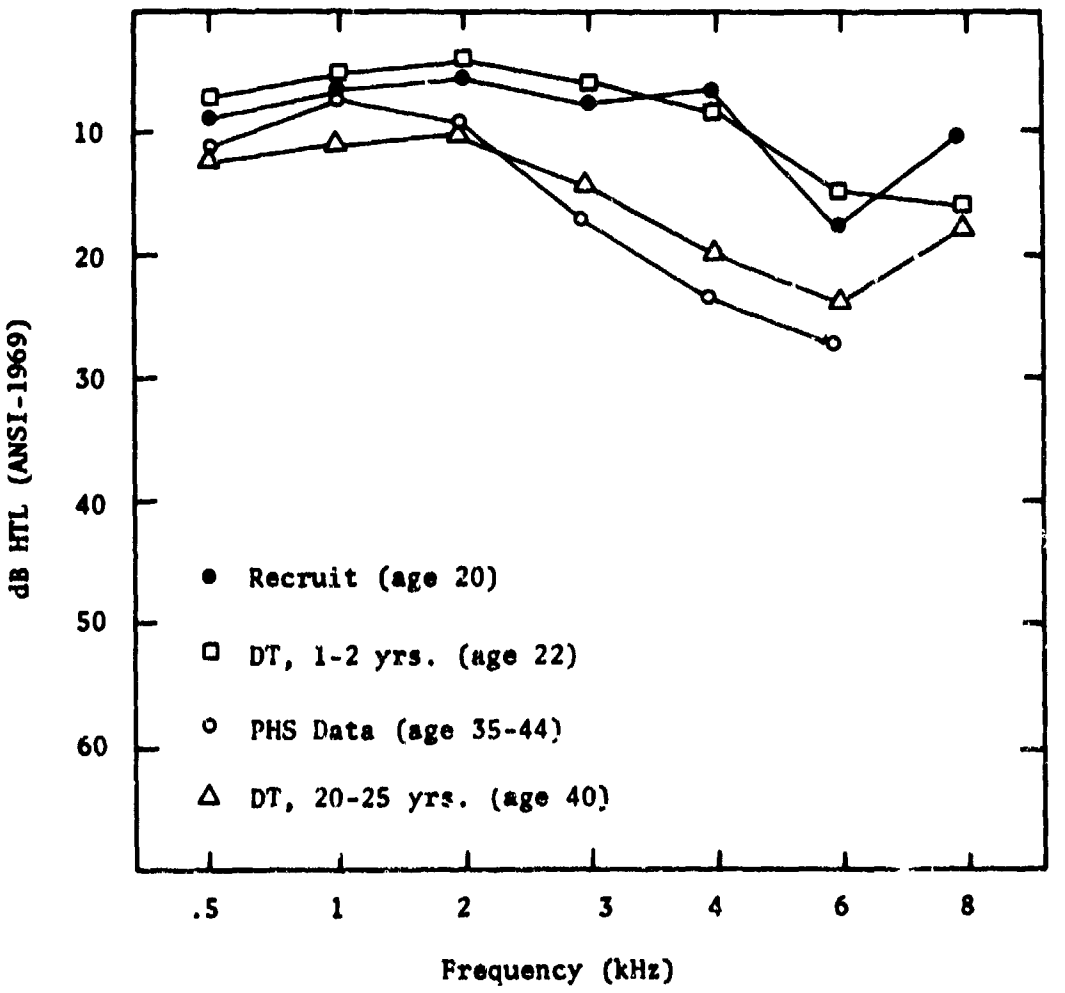


Figure C-9

Hearing threshold levels for dental technicians (DT) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

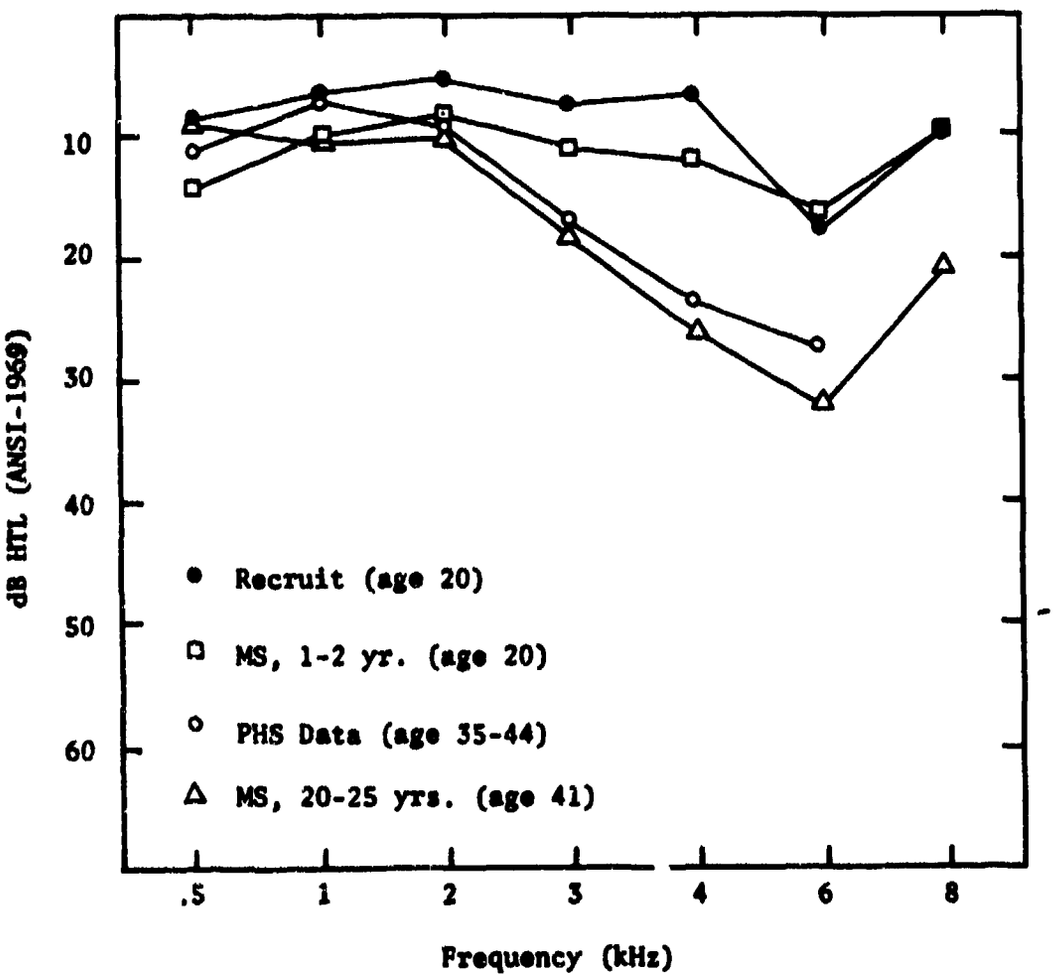


Figure C-10

Hearing threshold levels for mess management specialists (MS) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

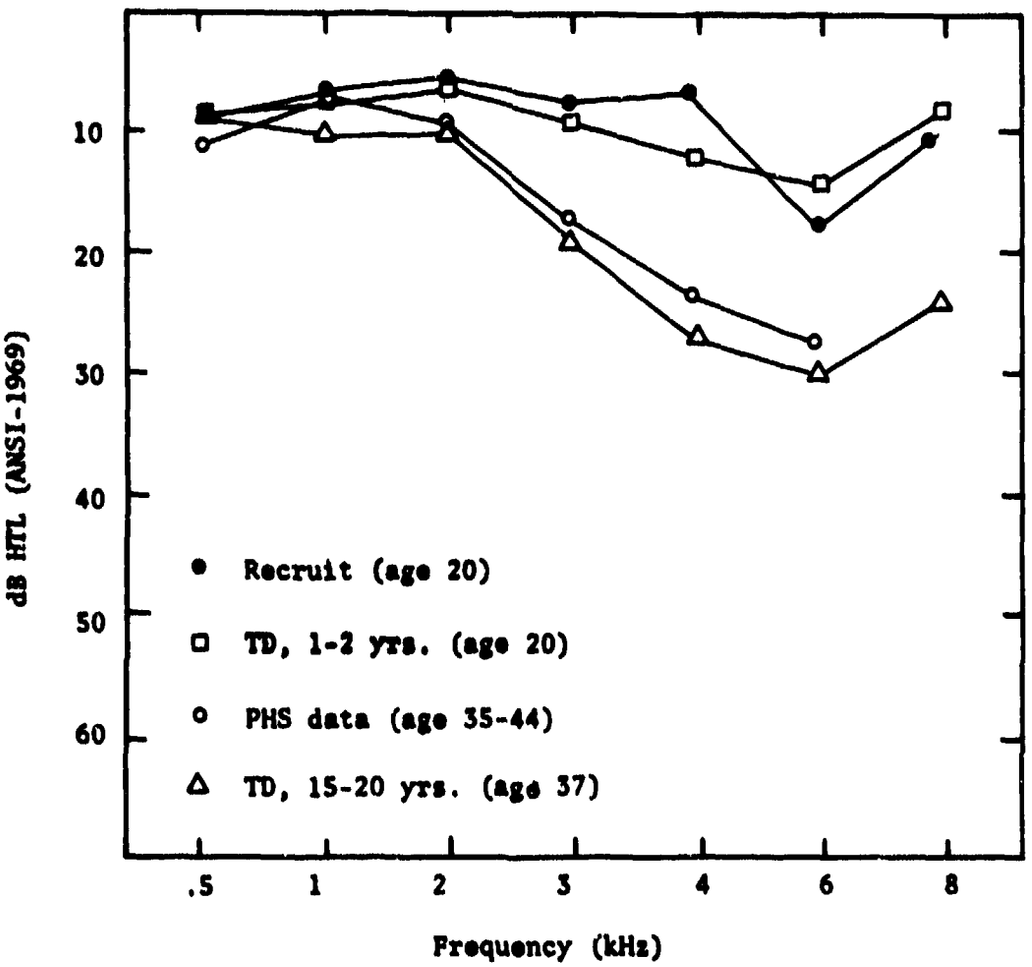


Figure C-11

Hearing threshold levels for training device technicians (TD) in 1-2 year and 15-20 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

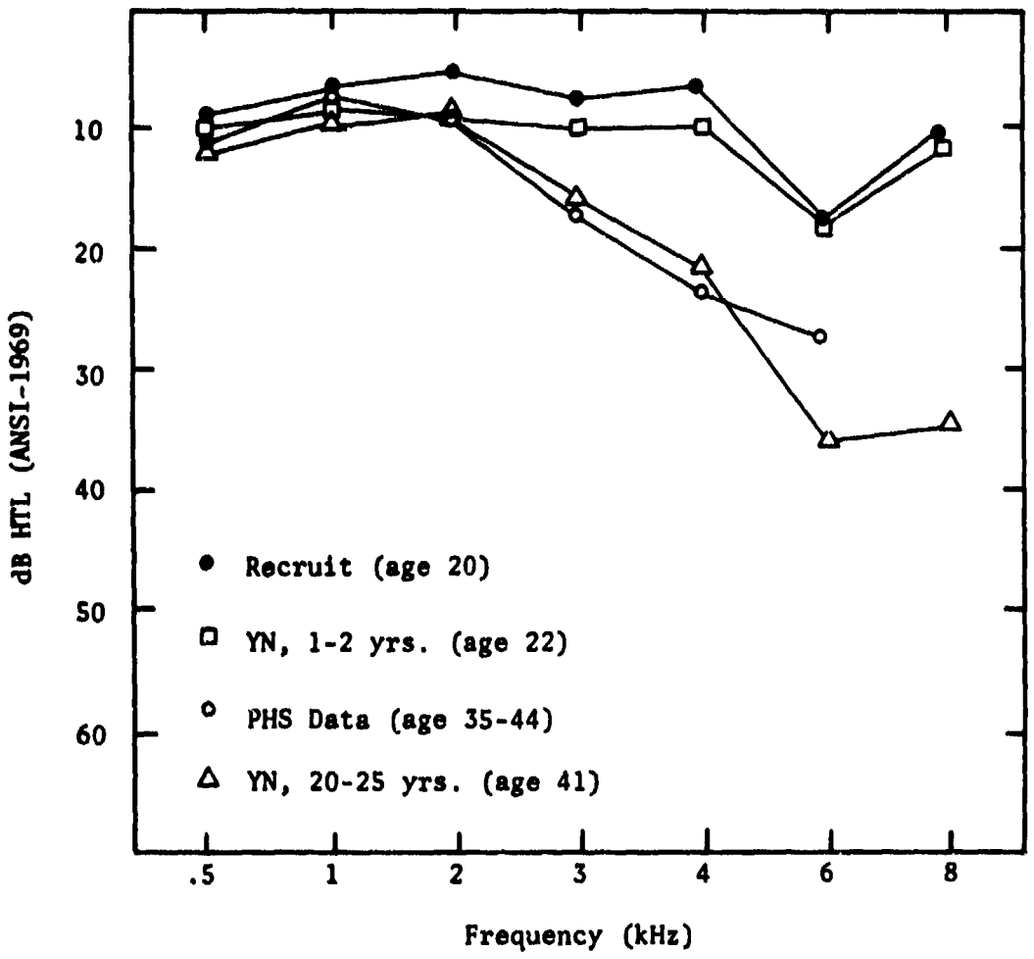


Figure C-12

Hearing threshold levels for yeomen (YN) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

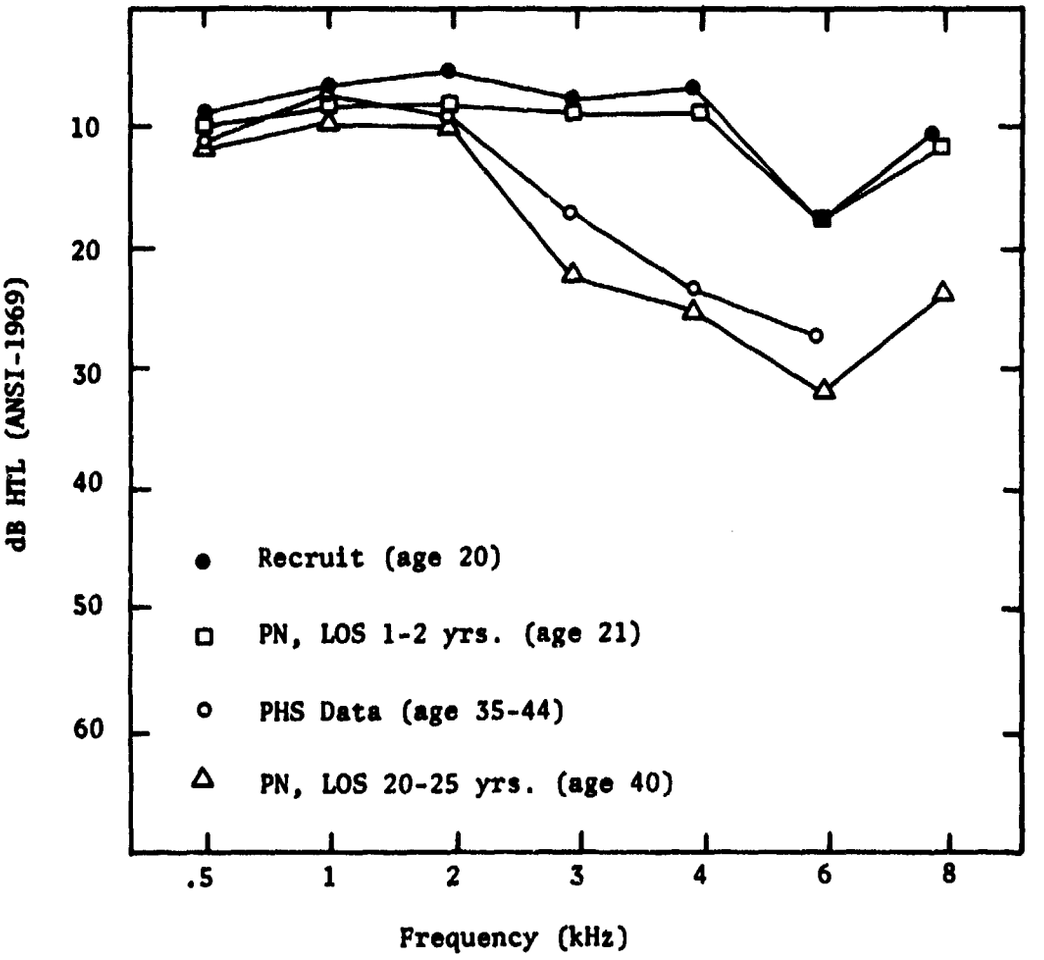


Figure C-13

Hearing threshold levels for personnelmen (PN) in 1-2 year and 20-25 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

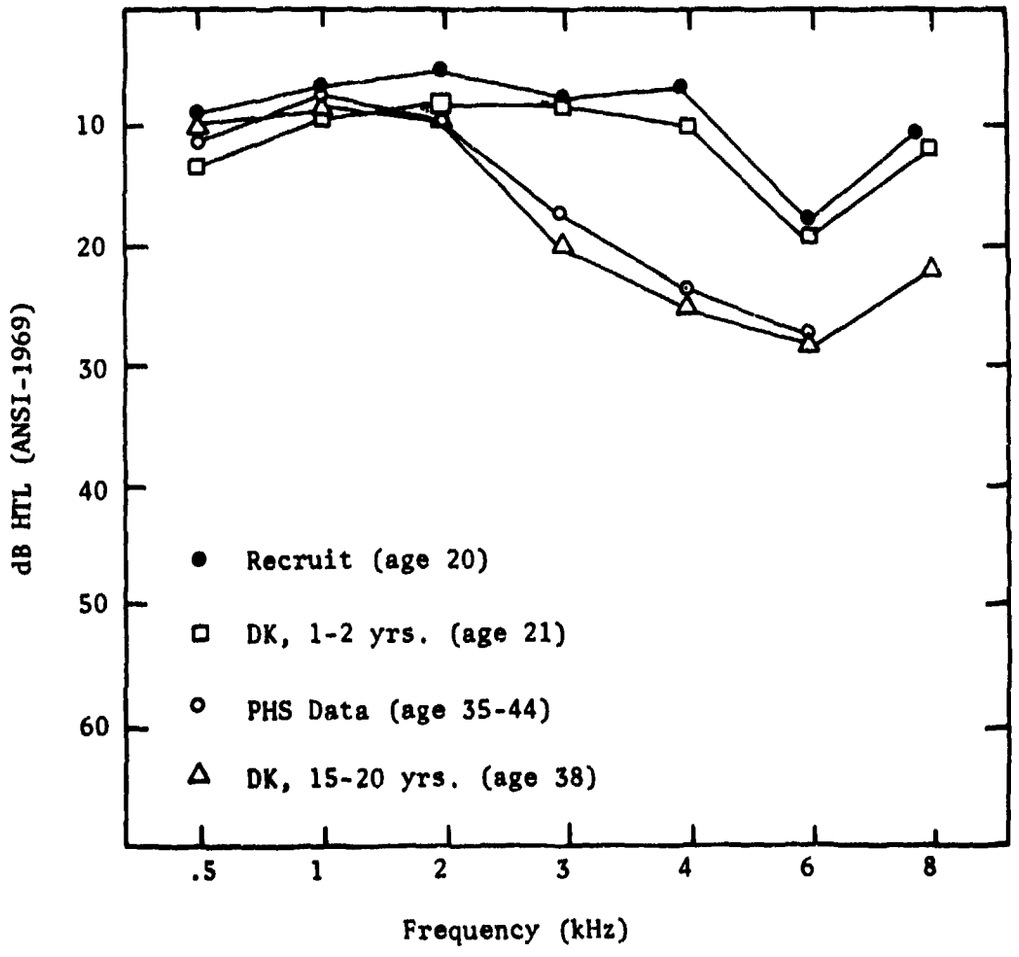


Figure C-14

Hearing threshold levels for disbursing clerks (DK) in 1-2 year and 15-20 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

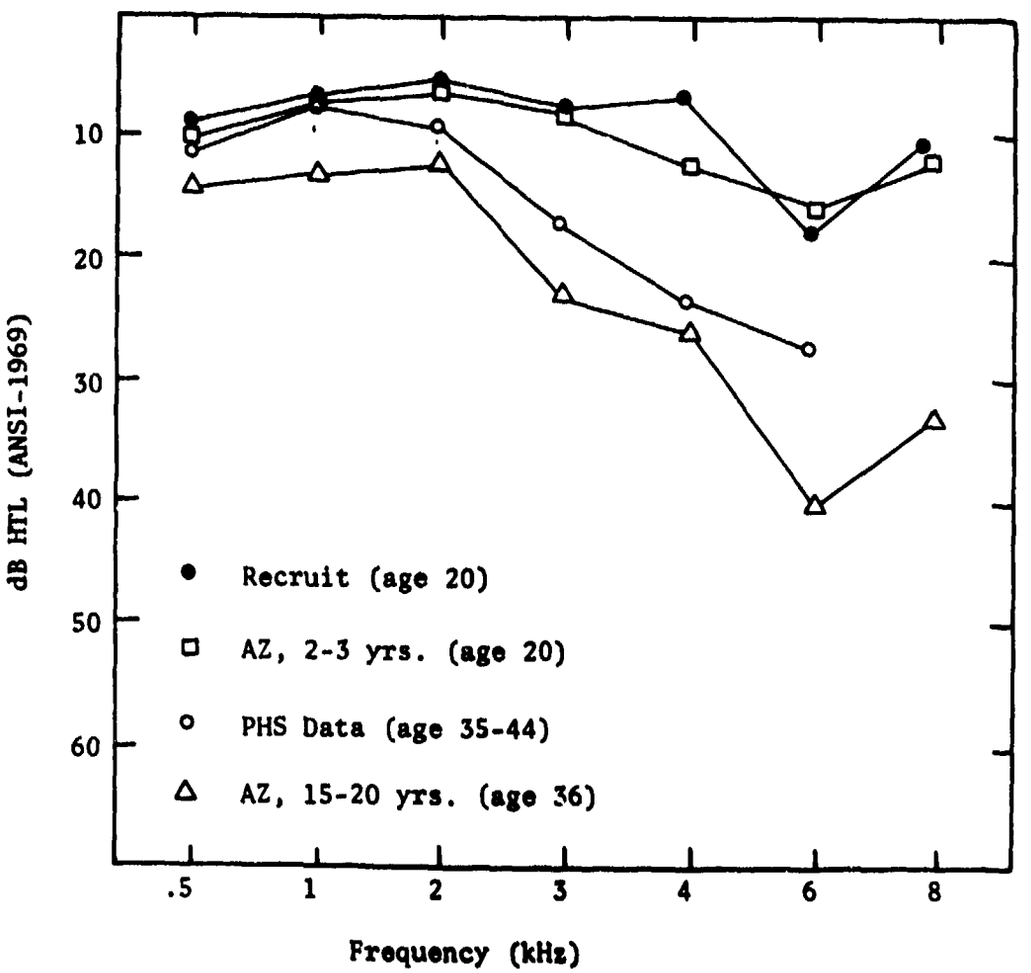


Figure C-15

Hearing threshold levels for aviation maintenance administrationmen (AZ) in 2-3 year and 15-20 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

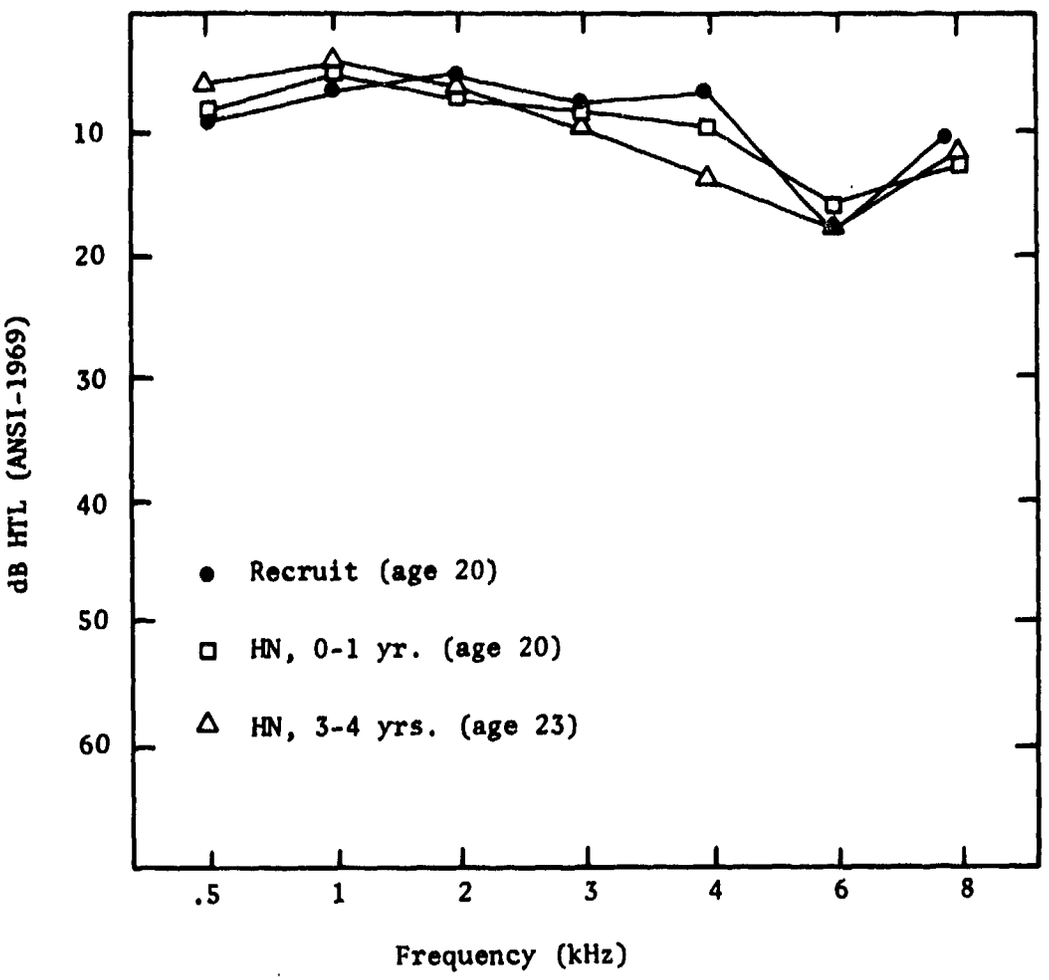


Figure C-16

Hearing threshold levels for hospitalmen (HN) in 0-1 year and 3-4 year LOS categories. Recruit data are shown for comparison (mean ages).

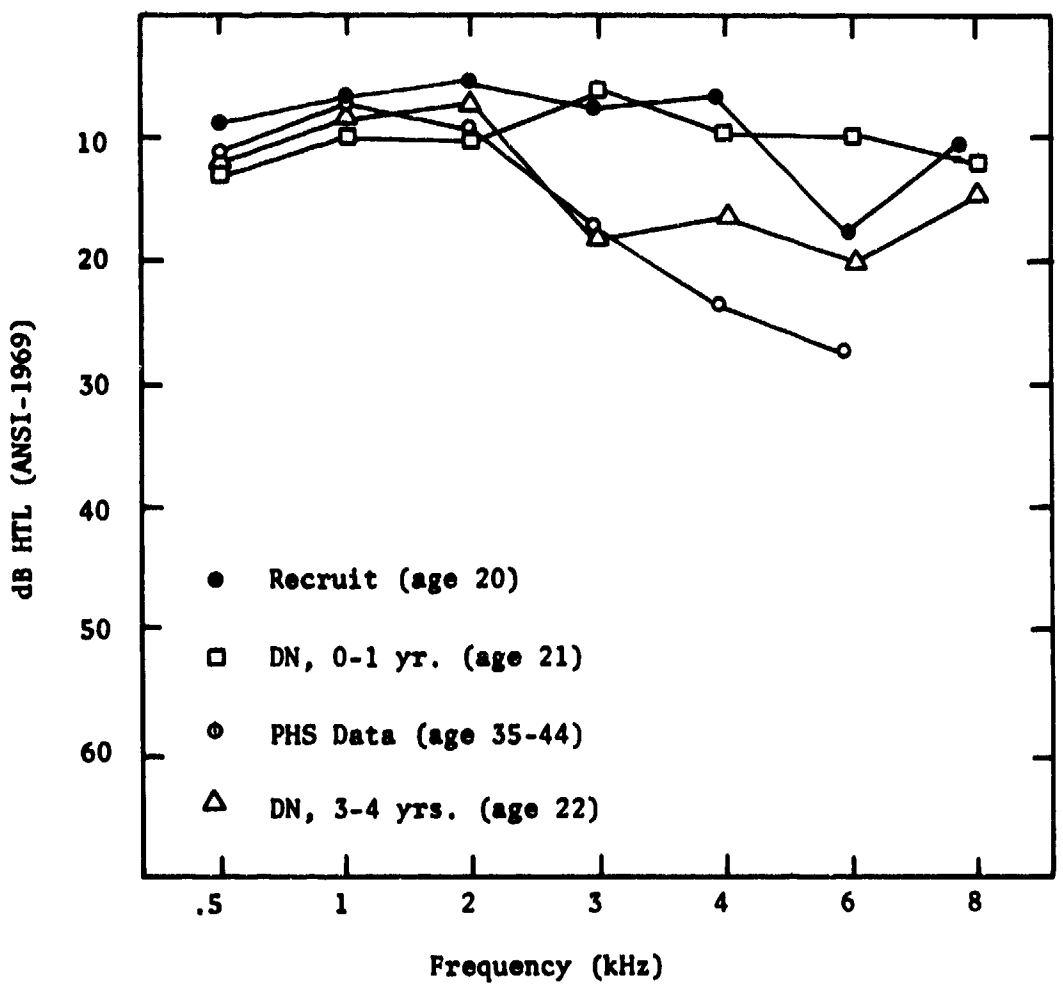
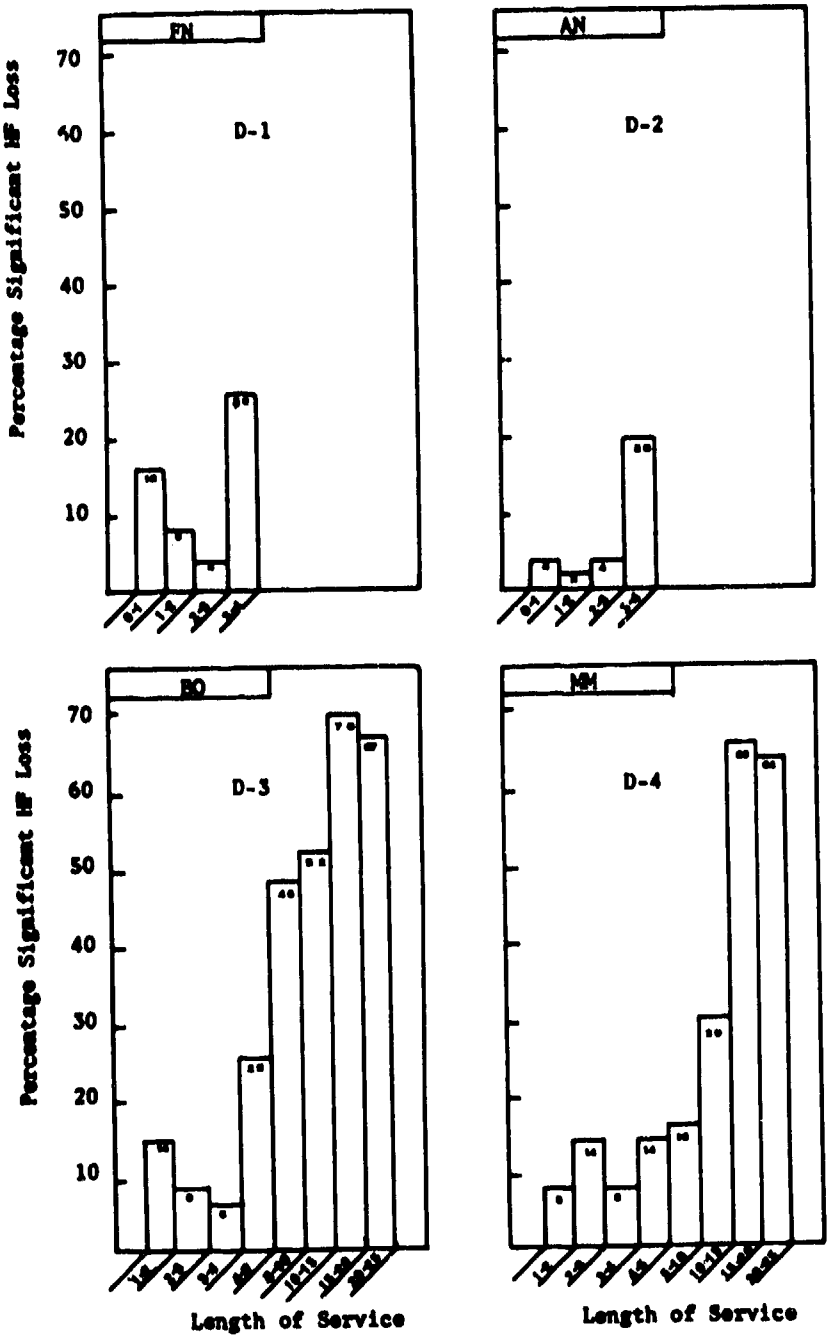


Figure C-17

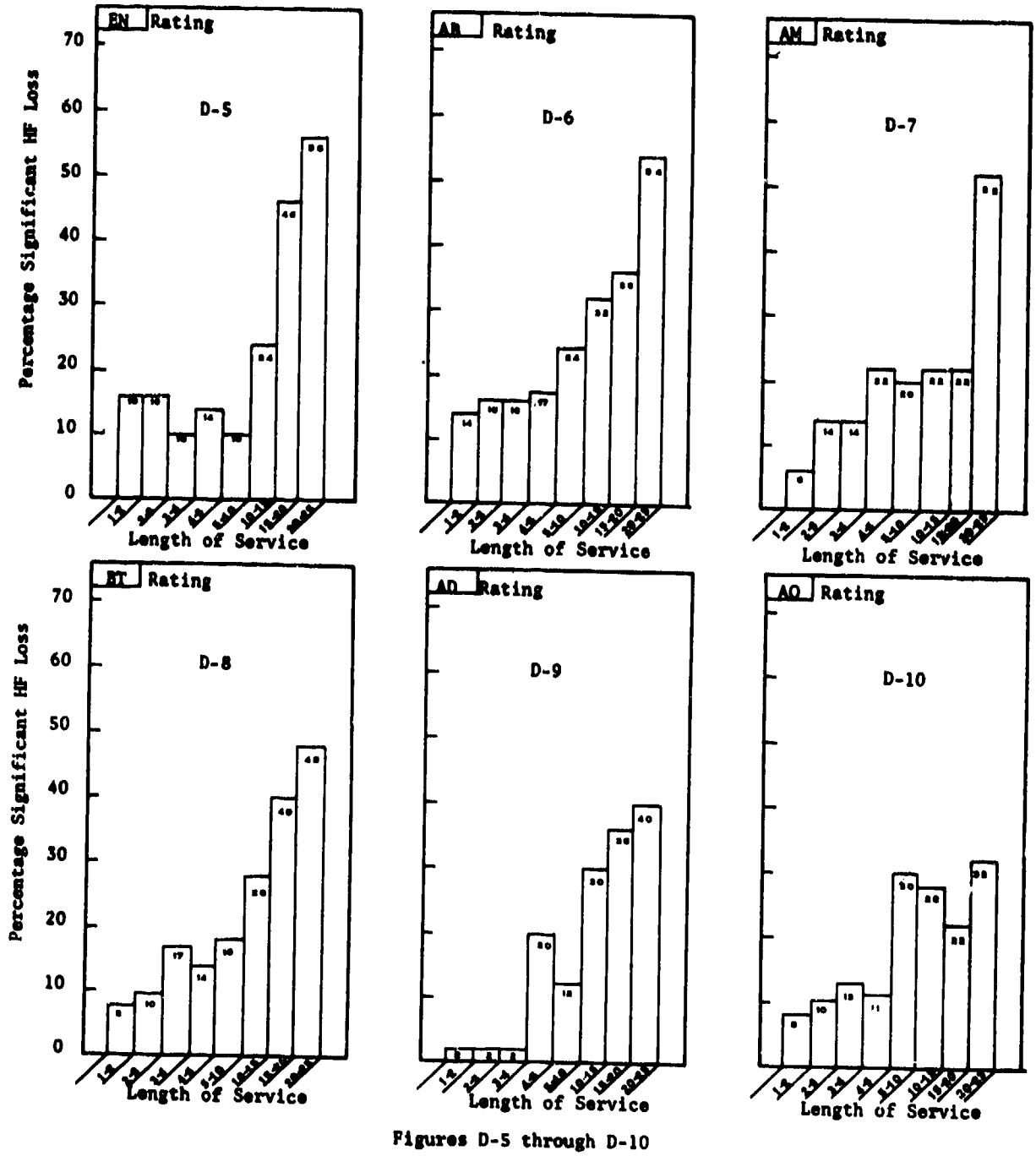
Hearing threshold levels for dentalmen (DN) in 0-1 year and 3-4 year LOS categories. Recruit and PHS data are shown for comparison (mean ages).

APPENDIX D



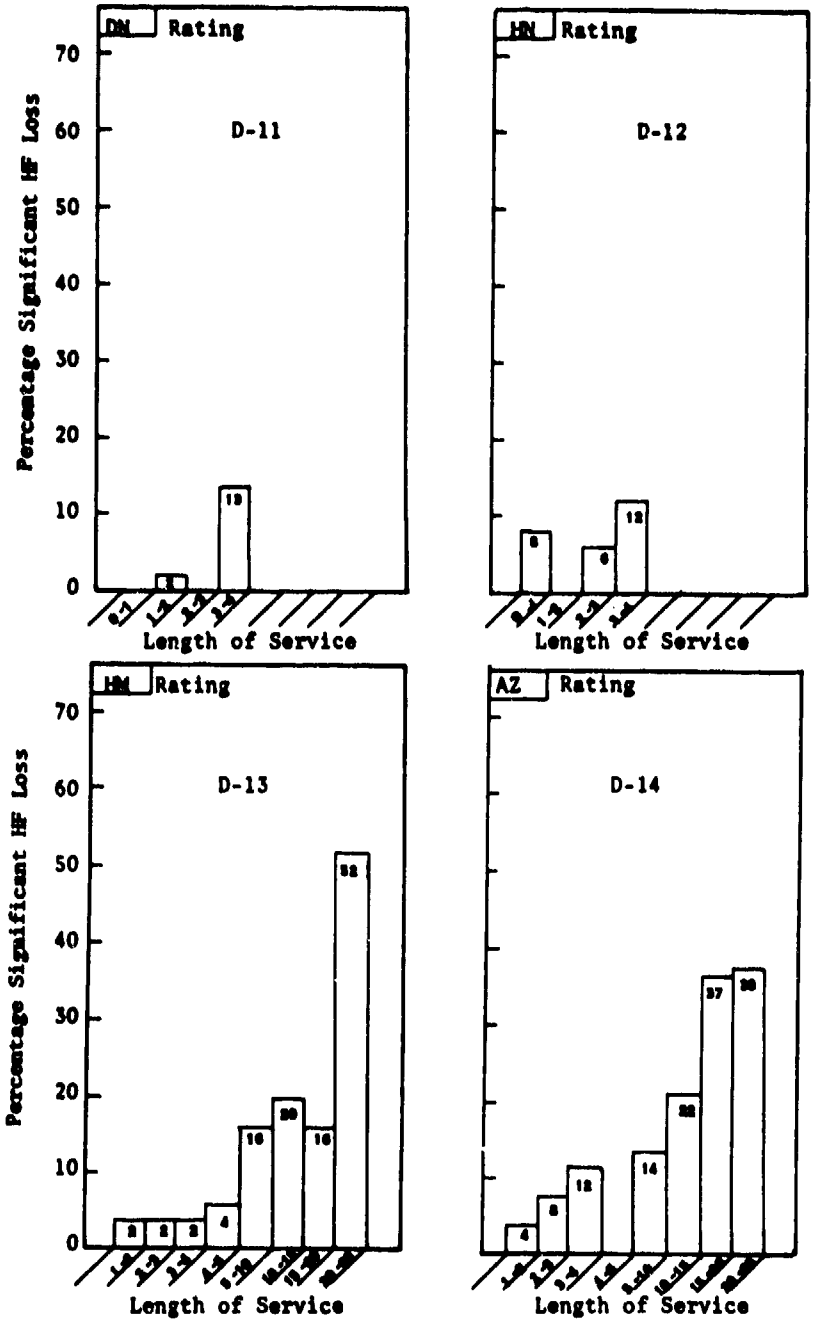
Figures D-1 through D-4

Percentage of significant high frequency (HF) hearing loss by ratings and length of service: experimental group.



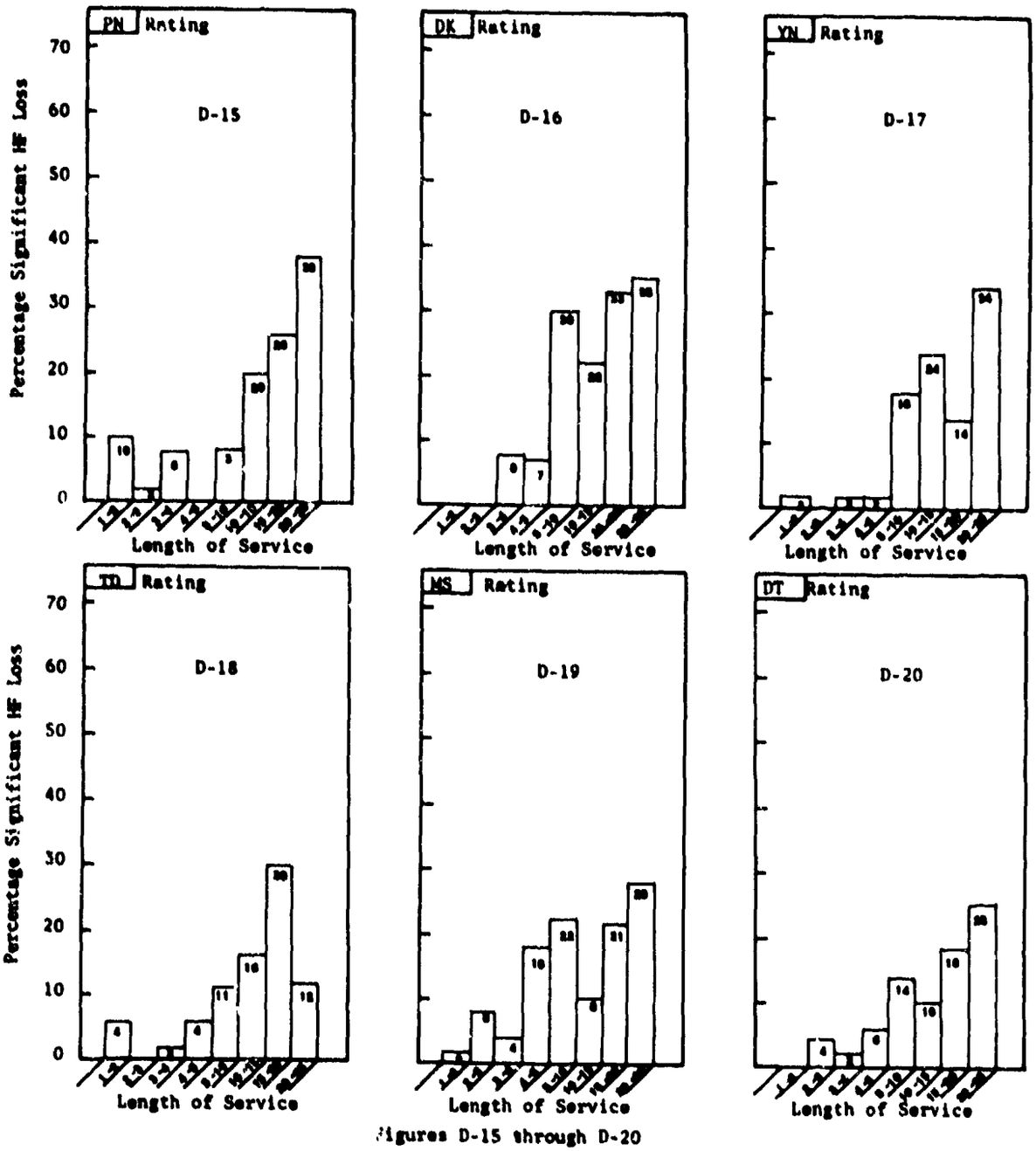
Figures D-5 through D-10

Percentage of significant high frequency hearing loss (HF) by ratings and length of service: experimental group.



Figures D-11 through D-14

Percentage of significant high frequency (HF) hearing loss by ratings and length of service: control group.



Figures D-15 through D-20

Percentage of significant high frequency (HF) hearing loss by ratings and length of service: control group.

APPENDIX E

Percentage of Significant Low Frequency Hearing Loss by Rating and Length of Service: Experimental and Control Groups

Experimental Group Length of Service (Yrs)									
Rate	0-1	1-2	2-3	3-4	4-5	5-10	10-15	15-20	20-25
FN	2	8	2	-	-	-	-	-	-
AN	4	-	-	14	-	-	-	-	-
MM	-	4	4	4	10	8	2	28	12
EN	-	4	8	4	-	2	6	10	16
AB	-	6	8	2	2	-	6	12	2
AM	-	-	-	-	-	2	6	-	12
BT	-	8	2	4	-	4	10	6	10
EO	-	-	-	-	2	10	10	4	-
AO	-	-	2	-	2	-	4	8	-
AD	-	2	-	-	4	2	-	4	4
Control Group Length of Service (Yrs)									
Rate	0-1	1-2	2-3	3-4	4-5	5-10	10-15	15-20	20-25
DN	7	-	4	-	-	-	-	-	-
HN	-	-	-	-	-	-	-	-	-
AZ	-	-	-	-	-	2	7	9	12
DT	-	-	-	-	6	-	10	-	10
PN	-	-	-	-	-	4	4	8	10
HM	-	-	-	-	-	-	-	2	8
MS	-	-	4	8	4	-	-	-	2
DK	-	-	2	-	2	-	6	5	-
YN	-	-	-	2	4	-	4	2	-
TD	-	-	-	-	-	4	-	-	6

APPENDIX F

Average hearing threshold levels for each LOS category by ear and frequency are shown in the Tables indicated for the following ratings and apprenticeships. Number of subjects, average age, and standard deviations are also shown.

Table F-1

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the Recruits*

	Right Ear							Left Ear							
N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
121	9(7)	8(6)	5(6)	7(8)	6(9)	16(12)	10(9)	7(5)	5(4)	5(5)	7(6)	7(8)	18(15)	11(11)	20(2)

Table F-2

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the DN Apprenticeship*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
0-1	7	16(7)	11(12)	14(18)	7(12)	9(9)	9(10)	14(11)	10(5)	8(9)	7(6)	4(7)	10(13)	10(10)	9(5)	21(2)
1-2	25	10(6)	7(6)	6(4)	7(7)	9(8)	14(12)	9(9)	9(5)	6(6)	7(6)	9(7)	10(9)	15(10)	7(6)	21(2)
2-3	25	15(6)	9(6)	6(6)	7(7)	9(8)	16(9)	15(14)	12(7)	9(7)	7(5)	9(7)	8(6)	16(9)	11(11)	21(1)
3-4	8	14(8)	9(6)	7(6)	18(20)	16(19)	20(18)	16(16)	11(4)	7(4)	7(7)	17(15)	15(21)	21(19)	14(17)	22(1)

Total = 65

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-3

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the HN Apprenticeship*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
0-1	25	10(5)	5(6)	6(5)	8(8)	8(12)	12(11)	12(12)	8(5)	5(4)	8(6)	9(9)	12(15)	19(18)	14(13)	20(1)
1-2	25	10(4)	6(4)	4(4)	4(4)	7(7)	13(10)	8(8)	7(3)	6(4)	4(6)	4(6)	4(5)	14(13)	8(7)	21(2)
2-3	25	8(6)	6(5)	5(5)	7(8)	8(11)	15(15)	8(11)	8(6)	6(6)	5(6)	6(7)	8(8)	16(12)	9(11)	21(1)
3-4	21	7(5)	4(4)	7(7)	10(14)	13(18)	17(18)	12(16)	6(5)	5(4)	5(5)	9(13)	15(16)	20(18)	12(14)	23(3)

Total = 96

Table F-4

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the AN Apprenticeship*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
0-1	25	13(7)	9(7)	10(7)	11(7)	12(7)	16(11)	14(13)	11(6)	9(6)	8(8)	9(8)	13(9)	19(12)	15(16)	20(2)
1-2	25	8(6)	6(6)	5(6)	7(5)	8(5)	15(10)	10(8)	9(6)	7(6)	6(6)	8(7)	14(12)	17(14)	10(11)	21)3)
2-3	25	9(6)	7(5)	6(6)	8(7)	14(15)	15(16)	12(16)	8(5)	6(5)	4(4)	9(8)	14(14)	15(14)	9(12)	21(1)
3-4	25	15(9)	13(10)	13(10)	15(11)	19(14)	21(19)	16(12)	15(11)	14(12)	14(12)	16(12)	20(14)	24(18)	19(14)	23(3)

Total = 100

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-5

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the FN Apprenticeship*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
0-1	25	14(6)	12(5)	11(6)	14(10)	21(19)	25(20)	14(15)	14(6)	13(6)	11(7)	18(13)	26(22)	26(22)	17(17)	19(2)
1-2	25	18(6)	15(6)	13(6)	13(6)	17(11)	21(10)	15(11)	16(6)	15(8)	14(12)	16(12)	20(15)	23(13)	17(16)	20(1)
2-3	25	15(7)	13(6)	10(6)	13(7)	11(7)	18(9)	9(8)	15(9)	14(9)	11(7)	15(9)	15(11)	22(12)	11(8)	21(3)
3-4	25	14(5)	12(5)	10(6)	14(12)	21(17)	25(19)	16(14)	14(5)	11(4)	11(7)	19(16)	24(13)	31(18)	20(16)	22(2)

Total = 100

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-6

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the DT Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	11	7(6)	5(4)	3(4)	4(7)	8(7)	14(21)	17(22)	7(7)	5(5)	4(5)	9(10)	9(8)	16(9)	15(15)	22(2)
2-3	25	9(5)	6(4)	6(5)	8(6)	7(10)	12(10)	11(9)	8(5)	5(5)	5(4)	7(6)	8(10)	11(10)	7(7)	22(2)
3-4	25	13(6)	8(5)	8(4)	5(4)	9(7)	16(12)	10(7)	9(5)	6(4)	8(5)	6(6)	9(12)	18(11)	9(9)	22(2)
4-5	25	8(8)	7(10)	6(9)	7(8)	9(11)	10(12)	10(9)	6(8)	7(12)	5(9)	9(12)	9(12)	11(14)	11(12)	23(3)
5-10	25	11(5)	8(5)	7(6)	12(9)	15(13)	21(13)	14(12)	10(6)	8(5)	10(7)	18(13)	21(18)	26(18)	16(15)	26(4)
10-15	25	10(8)	7(7)	9(15)	9(13)	13(18)	17(18)	17(19)	8(10)	7(8)	10(14)	12(15)	17(16)	23(17)	15(15)	32(4)
15-20	25	10(5)	9(5)	8(6)	13(11)	18(17)	29(18)	27(22)	8(6)	6(5)	8(7)	14(14)	18(18)	30(17)	21(16)	36(3)
20-25	20	15(16)	14(16)	11(13)	14(16)	19(16)	26(22)	20(21)	8(9)	8(7)	8(7)	14(12)	21(15)	22(20)	17(19)	40(3)
Total = 181																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-7

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the TD Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	8(5)	8(5)	6(6)	11(10)	13(11)	17(10)	9(9)	9(6)	6(6)	7(6)	7(10)	10(8)	12(10)	8(6)	20(2)
2-3	22	8(5)	7(5)	8(7)	8(6)	10(10)	14(12)	10(13)	9(6)	9(7)	7(6)	10(8)	10(9)	12(8)	7(7)	22(2)
3-4	20	6(3)	6(4)	6(5)	8(6)	12(9)	12(12)	10(8)	7(4)	7(3)	8(7)	8(8)	12(11)	14(15)	11(12)	22(2)
4-5	15	7(6)	8(7)	7(8)	10(10)	12(17)	14(17)	11(11)	8(8)	8(6)	8(8)	8(8)	10(9)	14(8)	10(7)	24(1)
5-10	27	8(6)	10(13)	9(8)	13(16)	15(17)	20(24)	14(20)	9(8)	8(5)	10(8)	13(16)	18(19)	24(22)	16(21)	26(2)
10-15	25	8(5)	7(7)	7(7)	13(11)	16(12)	19(13)	13(15)	8(8)	10(10)	9(9)	17(12)	21(16)	25(17)	15(14)	32(2)
15-20	25	8(5)	9(6)	9(7)	18(12)	27(21)	31(26)	25(25)	9(5)	10(6)	10(7)	20(14)	27(21)	30(21)	23(22)	37(2)
20-25	16	12(7)	9(8)	8(10)	15(14)	18(17)	24(20)	18(16)	12(8)	8(8)	11(10)	17(14)	21(14)	22(17)	20(19)	40(5)
Total = 175																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-8

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the YN Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	12(6)	9(6)	9(7)	11(7)	11(8)	17(10)	11(10)	9(7)	8(6)	9(6)	10(9)	10(10)	20(9)	13(13)	22(3)
2-3	25	13(5)	8(5)	7(4)	9(6)	8(6)	16(11)	12(10)	11(5)	9(6)	7(5)	8(7)	10(8)	13(7)	9(9)	22(2)
3-4	26	13(8)	10(6)	8(5)	8(5)	7(5)	17(13)	14(16)	11(7)	9(6)	7(5)	9(6)	9(8)	16(9)	8(8)	23(2)
4-5	25	14(8)	9(6)	7(8)	8(6)	9(8)	19(13)	11(9)	11(8)	8(5)	6(7)	7(5)	9(7)	17(9)	10(9)	23(2)
5-10	25	13(5)	9(6)	7(8)	12(10)	15(16)	25(17)	16(13)	11(5)	8(6)	8(8)	14(11)	16(16)	28(22)	20(17)	26(3)
10-15	25	14(8)	10(7)	10(8)	15(11)	20(16)	25(19)	16(17)	12(9)	10(8)	11(8)	17(11)	20(13)	25(16)	20(14)	32(3)
15-20	25	15(12)	10(11)	10(9)	14(12)	16(16)	26(20)	20(16)	8(6)	7(5)	8(6)	12(10)	18(18)	27(19)	21(19)	35(2)
20-25	24	13(6)	9(7)	7(8)	14(8)	23(18)	36(17)	32(20)	11(8)	9(5)	8(6)	18(18)	22(19)	37(20)	38(22)	41(3)
Total = 200																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-9

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the PN Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	11(4)	8(3)	9(9)	9(9)	9(11)	17(12)	11(11)	10(5)	7(4)	6(4)	9(6)	9(12)	19(15)	13(16)	21(2)
2-3	25	10(6)	8(4)	6(7)	8(7)	7(7)	17(10)	10(8)	8(7)	7(5)	7(7)	8(9)	9(10)	17(15)	12(12)	22(2)
3-4	25	11(6)	7(5)	7(5)	7(6)	12(17)	16(16)	13(15)	7(6)	5(5)	6(5)	8(9)	12(16)	19(17)	14(16)	23(2)
4-5	22	10(5)	8(4)	6(4)	7(8)	9(9)	14(10)	10(10)	10(6)	9(5)	8(5)	8(8)	10(8)	12(8)	8(7)	24(2)
5-10	24	11(6)	9(5)	7(5)	10(7)	10(9)	18(11)	13(10)	10(5)	8(6)	10(11)	14(14)	14(14)	23(15)	17(12)	26(2)
10-15	25	12(7)	12(5)	11(9)	16(14)	22(17)	27(18)	21(18)	13(6)	10(7)	9(8)	17(12)	21(16)	29(14)	19(10)	32(2)
15-20	25	14(8)	13(7)	10(7)	17(10)	21(17)	35(19)	27(18)	13(10)	11(7)	8(9)	18(16)	24(22)	35(20)	29(18)	36(2)
20-25	24	12(7)	11(9)	10(9)	21(13)	25(18)	33(24)	26(23)	10(9)	9(8)	11(10)	22(16)	25(17)	31(15)	23(15)	40(3)
Total = 195																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-10

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the HM Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	9(7)	6(6)	6(6)	7(7)	5(7)	12(7)	9(7)	7(6)	7(5)	4(5)	6(7)	10(10)	16(12)	11(7)	22(2)
2-3	25	10(6)	6(5)	6(6)	6(5)	7(9)	13(8)	10(8)	7(6)	6(6)	6(6)	5(6)	8(6)	14(8)	11(12)	22(2)
3-4	26	11(6)	7(5)	7(8)	6(5)	8(8)	15(10)	13(11)	10(8)	8(5)	6(6)	8(6)	9(9)	16(8)	11(7)	22(2)
4-5	25	9(5)	5(5)	5(5)	8(6)	12(10)	18(10)	10(6)	7(5)	6(5)	6(5)	9(6)	10(9)	14(10)	10(9)	23(2)
5-10	25	14(6)	8(6)	7(6)	9(11)	11(13)	26(16)	23(18)	11(6)	7(4)	7(7)	12(11)	16(17)	29(22)	17(19)	26(2)
10-15	25	12(5)	8(5)	8(5)	12(7)	18(18)	27(19)	23(19)	9(5)	7(4)	8(6)	13(13)	18(18)	27(18)	21(20)	31(2)
15-20	25	11(6)	8(6)	7(6)	12(12)	16(17)	34(22)	30(22)	8(6)	6(5)	6(6)	11(13)	14(14)	26(16)	22(18)	35(1)
20-25	25	13(7)	11(6)	10(7)	24(16)	32(22)	41(24)	32(25)	12(9)	13(9)	14(14)	28(20)	36(22)	42(22)	33(24)	42(3)
Total = 201																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-11

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the MS Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	13(6)	10(6)	8(7)	10(6)	10(7)	15(8)	8(8)	14(5)	10(5)	8(6)	12(8)	13(9)	16(9)	11(9)	20(1)
2-3	24	12(7)	10(7)	10(8)	13(8)	14(8)	16(10)	11(11)	12(7)	11(7)	11(8)	14(11)	14(10)	18(14)	11(11)	21(2)
3-4	25	14(8)	10(9)	9(7)	10(8)	11(8)	18(17)	13(15)	13(8)	9(8)	10(6)	12(6)	11(6)	17(11)	11(8)	22(2)
4-5	25	10(6)	8(8)	9(8)	12(7)	15(14)	23(16)	19(20)	10(5)	9(7)	9(6)	15(11)	25(20)	27(24)	22(20)	23(4)
5-10	25	11(4)	9(4)	9(5)	14(15)	25(22)	24(20)	15(18)	11(5)	10(5)	8(6)	13(13)	25(20)	26(18)	16(18)	29(4)
10-15	25	11(6)	10(5)	10(6)	14(8)	17(16)	25(20)	22(22)	10(5)	10(5)	9(4)	13(7)	16(8)	24(14)	16(13)	33(2)
15-20	25	10(4)	9(5)	11(6)	17(11)	23(17)	26(17)	16(9)	10(5)	8(4)	10(6)	17(14)	22(17)	26(17)	20(14)	38(2)
20-25	25	8(5)	8(4)	8(6)	16(10)	26(15)	33(19)	21(18)	10(8)	11(11)	11(10)	19(12)	27(17)	30(16)	21(16)	41(4)
Total = 199																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-12

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the DK Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	15	14(7)	9(6)	7(6)	8(4)	8(5)	16(7)	10(7)	12(8)	9(5)	8(4)	9(6)	11(9)	22(11)	15(9)	21(3)
2-3	27	12(9)	9(9)	7(6)	9(6)	8(6)	10(7)	8(9)	12(7)	7(6)	8(8)	8(7)	9(7)	13(8)	10(9)	22(3)
3-4	25	13(7)	9(7)	6(5)	12(12)	14(12)	19(18)	13(14)	11(6)	8(6)	8(7)	11(8)	15(15)	15(12)	12(14)	23(2)
4-5	22	9(8)	8(8)	10(12)	12(12)	15(16)	20(21)	16(18)	8(5)	7(4)	8(6)	10(6)	12(7)	14(12)	11(10)	24(2)
5-10	25	13(6)	11(7)	11(6)	16(16)	21(23)	28(23)	23(23)	13(7)	10(6)	11(6)	22(23)	23(24)	29(21)	19(17)	27(2)
10-15	23	11(7)	10(6)	10(6)	14(11)	23(22)	24(21)	22(22)	10(8)	13(8)	13(12)	27(12)	25(20)	29(18)	24(20)	32(3)
15-20	21	11(6)	8(8)	8(8)	19(15)	25(20)	28(19)	21(15)	10(7)	7(7)	10(8)	20(19)	25(20)	29(18)	22(17)	38(4)
20-25	10	9(4)	8(5)	8(6)	14(9)	24(17)	30(21)	30(23)	10(7)	9(4)	9(4)	22(12)	32(14)	36(18)	34(25)	42(3)
Total = 168																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-13

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the AE Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	11	10(6)	7(5)	5(5)	8(9)	6(7)	19(18)	14(15)	9(6)	8(5)	8(10)	7(8)	10(8)	21(17)	10(12)	20(2)
2-3	25	11(6)	8(5)	7(6)	8(8)	12(11)	16(12)	8(7)	9(8)	6(4)	5(5)	8(14)	12(17)	17(19)	17(18)	22(2)
3-4	24	13(7)	9(6)	9(8)	11(13)	18(18)	18(14)	14(13)	10(6)	9(6)	7(7)	11(11)	14(14)	15(11)	12(10)	22(2)
4-5	23	9(6)	6(4)	6(5)	7(7)	8(11)	13(7)	10(8)	7(5)	6(5)	4(4)	8(6)	10(9)	15(9)	9(6)	24(2)
5-10	25	14(7)	9(6)	9(7)	14(10)	17(15)	26(23)	20(17)	10(6)	8(6)	10(8)	17(18)	14(10)	22(21)	13(9)	27(3)
10-15	27	13(6)	10(6)	10(9)	14(10)	17(12)	27(18)	15(12)	12(8)	10(6)	10(8)	15(13)	24(19)	25(20)	17(15)	32(3)
15-20	23	14(7)	12(7)	13(7)	22(17)	24(21)	40(25)	33(25)	14(7)	14(7)	11(8)	23(16)	28(24)	41(23)	33(27)	36(3)
20-25	12	11(9)	11(8)	12(8)	19(15)	23(14)	29(18)	29(12)	12(8)	9(9)	14(7)	15(12)	25(12)	32(15)	25(14)	40(2)

Total = 170

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-14

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the AD Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	10(5)	7(6)	6(6)	8(7)	9(8)	13(10)	13(15)	12(1.)	6(5)	5(6)	9(10)	11(15)	14(11)	13(15)	20(2)
2-3	25	8(4)	6(4)	4(4)	5(5)	7(7)	14(8)	9(8)	7(4)	6(4)	4(4)	7(8)	7(8)	17(14)	11(15)	21(1)
3-4	25	10(5)	9(4)	5(6)	9(8)	11(10)	16(13)	7(7)	10(5)	8(6)	7(8)	11(8)	13(10)	17(12)	11(13)	22(1)
4-5	25	12(6)	12(6)	12(9)	16(10)	19(15)	28(20)	22(19)	13(9)	10(9)	12(9)	16(10)	17(13)	27(15)	17(14)	23(1)
5-10	25	10(6)	9(4)	7(6)	8(8)	10(13)	21(14)	12(12)	10(5)	8(7)	8(11)	11(11)	15(12)	25(20)	14(13)	28(3)
10-15	25	10(4)	10(7)	7(5)	16(11)	24(16)	31(20)	18(18)	8(5)	7(5)	8(7)	18(10)	28(17)	31(22)	18(18)	32(2)
15-20	25	11(7)	11(8)	8(8)	17(16)	23(18)	32(25)	24(24)	9(6)	8(8)	9(10)	20(18)	30(24)	32(22)	22(20)	37(3)
20-25	25	11(8)	12(8)	10(9)	18(15)	27(18)	33(19)	25(22)	11(9)	10(7)	10(10)	20(16)	32(18)	40(22)	27(18)	40(3)
To al = 200																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-15

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the AO Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	12(6)	8(5)	8(6)	11(8)	13(12)	19(12)	12(8)	11(6)	9(5)	9(7)	12(7)	13(11)	23(13)	10(8)	20(1)
2-3	25	13(6)	9(6)	7(6)	9(7)	9(8)	17(15)	12(13)	11(6)	8(6)	9(8)	12(12)	14(14)	17(17)	14(14)	21(1)
3-4	23	12(5)	8(5)	5(4)	7(6)	14(16)	18(17)	14(15)	11(6)	7(5)	5(4)	7(7)	15(15)	24(19)	18(23)	21(1)
4-5	24	12(8)	8(8)	6(9)	10(14)	16(20)	19(17)	15(18)	10(5)	6(5)	6(5)	9(11)	13(15)	20(13)	18(18)	22(2)
5-10	25	13(6)	10(6)	6(5)	16(12)	21(19)	28(18)	16(16)	12(8)	8(6)	7(6)	19(17)	24(23)	37(25)	24(22)	25(2)
10-15	23	13(5)	12(14)	8(9)	14(12)	20(18)	31(18)	23(23)	10(6)	8(6)	8(6)	17(14)	23(18)	30(17)	20(15)	31(2)
15-20	21	14(8)	10(9)	8(7)	16(16)	20(18)	33(17)	22(18)	11(8)	9(8)	9(9)	20(16)	23(17)	32(17)	25(20)	36(2)
20-25	23	13(8)	10(6)	10(8)	21(20)	28(28)	33(28)	26(24)	10(7)	8(6)	13(12)	21(17)	28(24)	30(25)	27(23)	41(4)
Total = 189																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-16

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the AM Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	11(6)	10(5)	6(6)	8(7)	11(10)	13(9)	7(7)	9(6)	8(6)	7(6)	9(8)	13(11)	18(10)	10(8)	20(1)
2-3	25	11(6)	8(6)	7(7)	12(11)	14(11)	18(20)	10(16)	9(6)	7(5)	8(8)	15(14)	16(15)	23(22)	13(16)	21(1)
3-4	25	10(6)	8(5)	5(5)	10(11)	13(16)	22(16)	12(12)	10(6)	7(5)	5(4)	13(15)	14(15)	25(18)	18(13)	23(2)
4-5	25	13(6)	9(6)	8(8)	13(14)	18(22)	27(20)	17(19)	12(7)	9(6)	9(8)	13(14)	19(19)	25(17)	19(18)	24(1)
5-10	25	10(6)	9(5)	6(6)	11(9)	19(17)	23(16)	14(13)	9(7)	8(6)	9(9)	17(15)	22(20)	30(21)	17(19)	26(2)
10-15	25	11(7)	10(7)	9(11)	15(13)	20(20)	24(18)	16(16)	9(7)	9(9)	9(12)	17(16)	29(19)	26(17)	18(15)	32(2)
15-20	25	13(7)	11(7)	6(6)	12(9)	17(12)	30(16)	21(15)	12(7)	9(6)	8(6)	14(11)	23(13)	28(15)	23(16)	35(2)
20-25	25	15(8)	13(9)	15(14)	24(19)	34(21)	48(24)	35(25)	13(8)	13(10)	16(17)	25(20)	34(19)	45(18)	37(22)	40(3)

Total = 200

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-17

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the EN Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	15(6)	11(6)	11(8)	14(10)	17(15)	18(12)	10(10)	13(6)	10(6)	11(8)	14(12)	18(14)	19(18)	14(13)	20(2)
2-3	25	16(7)	12(6)	9(8)	13(12)	16(14)	22(17)	15(17)	16(9)	13(9)	10(10)	17(16)	22(19)	23(16)	16(20)	21(2)
3-4	25	13(6)	10(5)	8(6)	11(7)	15(12)	21(19)	13(13)	14(6)	11(6)	11(10)	14(8)	18(16)	24(13)	18(14)	22(2)
4-5	25	9(6)	9(6)	8(6)	11(11)	17(17)	21(20)	14(18)	9(6)	8(6)	9(7)	12(9)	15(15)	21(21)	18(21)	23(2)
5-10	25	10(5)	8(4)	7(6)	13(11)	15(16)	20(20)	14(17)	10(7)	9(6)	10(7)	13(11)	14(16)	22(20)	15(16)	26(3)
10-15	25	12(7)	11(6)	11(9)	17(12)	20(13)	28(16)	21(14)	11(6)	11(7)	10(7)	18(12)	22(16)	30(18)	22(17)	32(3)
15-20	25	13(8)	12(9)	12(12)	24(13)	29(16)	34(16)	23(13)	14(13)	10(7)	11(11)	26(14)	30(15)	32(14)	26(12)	36(2)
20-25	16	14(10)	16(12)	20(16)	29(24)	29(24)	36(27)	33(27)	12(9)	13(9)	21(15)	34(23)	40(25)	36(26)	28(23)	43(6)
Total = 191																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-18

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the BT Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	16(7)	15(7)	11(9)	15(10)	16(14)	21(15)	14(13)	15(7)	14(8)	13(10)	18(11)	21(13)	25(15)	18(14)	19(1)
2-3	25	16(6)	15(8)	14(7)	14(7)	19(17)	29(21)	22(22)	15(5)	13(6)	11(7)	14(8)	20(14)	25(19)	17(17)	21(1)
3-4	24	13(5)	10(5)	11(11)	17(14)	18(15)	21(11)	14(10)	14(5)	12(6)	11(10)	15(13)	17(12)	23(12)	14(10)	22(2)
4-5	26	14(6)	11(5)	10(6)	13(9)	17(10)	22(12)	17(10)	13(6)	11(4)	10(6)	16(9)	19(10)	28(14)	20(14)	23(2)
5-10	25	10(8)	10(7)	6(8)	11(10)	16(13)	22(15)	14(14)	11(8)	11(9)	8(8)	14(11)	20(15)	25(20)	21(17)	27(2)
10-15	25	15(5)	16(9)	14(10)	22(19)	27(24)	33(24)	21(17)	14(7)	16(10)	18(17)	27(24)	31(24)	37(22)	22(17)	30(3)
15-20	25	12(5)	11(7)	11(11)	25(19)	30(17)	33(15)	20(14)	11(7)	11(9)	14(16)	28(16)	32(18)	38(15)	25(19)	36(2)
20-25	25	11(6)	10(7)	13(14)	25(16)	33(18)	31(19)	26(20)	10(6)	12(11)	18(17)	28(18)	39(17)	36(21)	24(19)	39(3)
Total = 200																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-19

Average Hearing Threshold Level Data by LOS, Ear and Frequency for the AB Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	15(8)	14(8)	11(8)	13(8)	20(14)	25(16)	19(15)	13(7)	13(7)	9(7)	16(13)	19(18)	25(18)	19(14)	20(2)
2-3	25	12(6)	10(4)	9(8)	15(10)	16(11)	22(15)	14(14)	11(6)	10(7)	11(10)	15(15)	19(18)	26(17)	18(13)	21(1)
3-4	25	13(7)	11(5)	11(6)	14(10)	21(17)	27(26)	23(25)	11(6)	11(6)	12(6)	15(8)	18(11)	27(19)	18(19)	23(2)
4-5	26	13(6)	11(6)	11(7)	15(9)	19(13)	22(13)	11(7)	13(6)	9(6)	10(6)	16(12)	20(15)	24(17)	14(15)	24(1)
5-10	25	12(5)	11(6)	7(6)	13(10)	21(16)	27(18)	17(15)	10(7)	7(6)	8(7)	16(16)	21(18)	32(16)	19(15)	26(2)
10-15	28	12(7)	10(5)	10(8)	17(12)	24(15)	34(18)	22(17)	11(6)	7(5)	11(10)	18(15)	24(19)	31(19)	20(17)	32(3)
15-20	25	14(9)	13(7)	12(13)	18(17)	24(21)	35(23)	25(24)	14(9)	13(6)	16(15)	25(21)	31(23)	37(21)	24(20)	36(2)
20-25	25	12(6)	11(7)	13(11)	27(18)	36(20)	33(23)	27(20)	11(7)	9(8)	14(10)	28(20)	37(24)	39(25)	25(23)	41(3)
Total = 204																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

Table F-20

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the MM Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	14(5)	12(6)	11(7)	12(8)	13(10)	16(12)	12(9)	13(5)	12(5)	11(8)	12(10)	15(12)	21(13)	11(8)	20(1)
2-3	25	15(5)	11(6)	10(8)	13(15)	17(16)	19(13)	13(8)	14(7)	10(6)	10(11)	14(16)	16(15)	28(21)	17(20)	21(1)
3-4	25	12(4)	11(6)	11(7)	13(11)	14(15)	20(17)	12(14)	11(6)	11(5)	12(7)	15(9)	17(10)	21(11)	13(10)	23(2)
4-5	25	15(8)	12(9)	11(9)	12(10)	15(13)	21(15)	13(14)	14(6)	12(9)	12(10)	16(12)	18(11)	25(12)	12(10)	24(2)
5-10	25	13(12)	11(14)	11(16)	15(15)	17(17)	23(13)	14(12)	13(10)	10(11)	9(10)	15(12)	18(13)	25(12)	17(12)	26(3)
10-15	25	11(7)	11(6)	8(6)	23(22)	28(24)	32(25)	10(23)	10(10)	8(6)	9(8)	20(20)	27(20)	27(16)	18(16)	31(2)
15-20	25	19(10)	17(8)	20(15)	34(20)	35(18)	40(15)	30(14)	20(12)	17(13)	24(18)	38(18)	40(18)	42(16)	34(16)	36(2)
20-25	25	16(12)	17(12)	17(12)	33(20)	46(20)	45(22)	38(22)	12(6)	12(8)	15(10)	28(17)	41(21)	42(25)	33(25)	40(2)
Total = 200																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject are are also shown.

Table F-21

Average Hearing Threshold Level Data by LOS, Ear, and Frequency for the EO Rating*

		Right Ear							Left Ear							
LOS	N	500	1000	2000	3000	4000	6000	8000	500	1000	2000	3000	4000	6000	8000	Age
1-2	25	10(7)	8(6)	6(5)	10(9)	14(12)	21(14)	15(16)	8(5)	7(5)	6(4)	10(9)	17(18)	21(19)	14(14)	21(2)
2-3	25	12(6)	9(6)	9(6)	12(11)	13(10)	27(16)	16(13)	9(6)	6(5)	7(5)	12(8)	12(10)	17(12)	13(13)	20(1)
3-4	25	12(6)	9(6)	10(8)	10(6)	10(8)	21(15)	14(13)	11(6)	9(5)	11(8)	11(8)	13(13)	20(10)	12(10)	22(1)
4-5	20	9(6)	8(7)	7(6)	12(9)	16(14)	25(13)	16(13)	8(5)	8(7)	6(6)	16(12)	18(16)	32(22)	19(19)	23(3)
5-10	26	12(6)	12(8)	13(11)	26(19)	33(26)	37(24)	24(27)	10(5)	11(8)	16(13)	29(23)	32(26)	40(25)	28(23)	28(3)
10-15	25	14(7)	12(6)	11(7)	26(20)	31(20)	39(23)	33(24)	13(9)	10(11)	13(14)	28(20)	33(23)	45(22)	33(24)	33(4)
15-20	25	11(7)	10(7)	15(12)	33(22)	40(23)	45(24)	34(24)	10(10)	9(9)	15(13)	32(22)	42(22)	49(23)	37(22)	38(4)
20-25	6	10(5)	9(5)	17(12)	36(22)	39(30)	55(26)	40(28)	5(4)	6(5)	13(12)	40(24)	39(23)	50(29)	38(21)	41(1)
Total = 177																

*Standard deviations are shown in parentheses. Total subjects per LOS category and average subject age are also shown.

APPENDIX G

Estimated Number of Personnel with Significant
High Frequency Hearing Loss by Rating

Experimental Group				Control Group			
Rating	Current Population*	Percentage of Sample	Estimated Number	Rating	Current Population*	Percentage of Sample	Estimated Number
AN	17,582	8	1,406	HN	4,905	7	343
FN	16,784	14	2,350	DN	729	4	29
EO	2,378	36	856	HM	16,569	14	2,320
MM	23,113	28	6,472	DT	2,148	9	193
EN	8,179	24	1,963	MS	16,217	14	2,270
BT	10,398	23	2,392	YN	10,682	12	1,281
AM	15,483	22	3,406	PN	6,359	14	890
AD	12,357	18	2,224	DK	2,297	17	390
AB	5,577	26	1,450	TD	1,937	10	194
AO	5,639	18	1,015	AZ	2,978	17	506
TOTAL	117,490		23,534		64,821		8,416

*On-board population valid through April 1978.

APPENDIX H

Questionnaire Responses

Figures H-1 through H-6 show the percentage of affirmative responses for the following questions:*

1. Do you think you have normal hearing?

2. Do you now or have you ever had head noises?

3. Do you have problems understanding speech in any situation?

4. Prior to military service, did you work in jobs, either part time or full time, in which the noise levels were such that you had to raise your voice to be understood?

5. Have you ever been in combat?

6. Do you now or have you in the past participated regularly in any hobby or off-job activity that is typically noisy?

Data presented in Figure H-1a are consistent with the hearing threshold level data already discussed (Figure 7). Subjective impressions of normal hearing decline with time for both groups, the control group yielding a higher percentage of affirmative responses. The data in H-1b show that despite the fact the DK, AZ, AD, and AO ratings displayed the same proportion of high frequency hearing loss (Figure 9), there is an approximately 6 percent difference in "yes" responses to Question 1. Also, even though the EO rating displayed the worst high frequency hearing in the experimental group (36 percent), they showed the same percentage of subjective normal hearing as did the AD rating which showed one-half the prevalence of high frequency hearing loss.

Although no definitive reason for these findings can be offered, a few speculations can be presented. It could be that personnel are reluctant to state their true opinion of their hearing. Another reason might be that there is less of a correlation between high frequency hearing loss (as defined in this study) and the subjective impression that one has a hearing loss than would be expected. Still another speculation is that people classify themselves into "quiet" and "noisy" ratings, and this affects their subjective impression of their hearing status.

The incidence of tinnitus is quite low (Figure H-2) and apparently bears little relationship to either rating or length of service. One would have expected an increase in the incidence of tinnitus over time and a larger separation between the experimental and control groups.

- - - - - - - - - - -

*The question numbers shown are not the same as those in the questionnaire and will be used in subsequent figures as indicated.

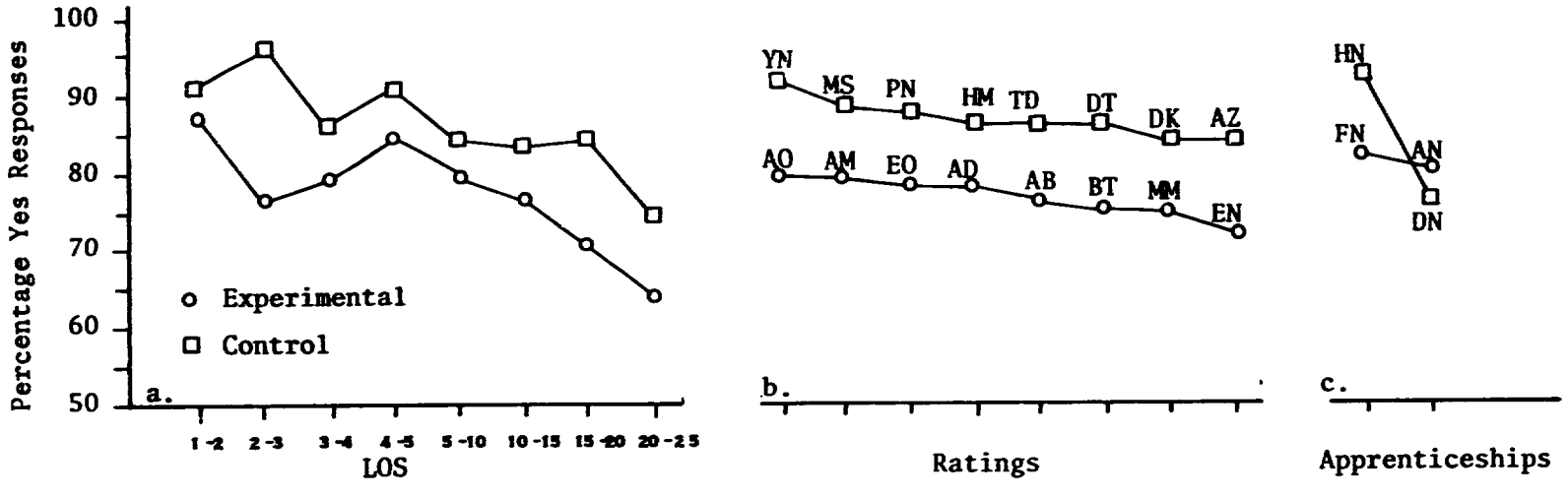


Figure H-1

Percentage of affirmative responses to Question 1: Do you think you have normal hearing?

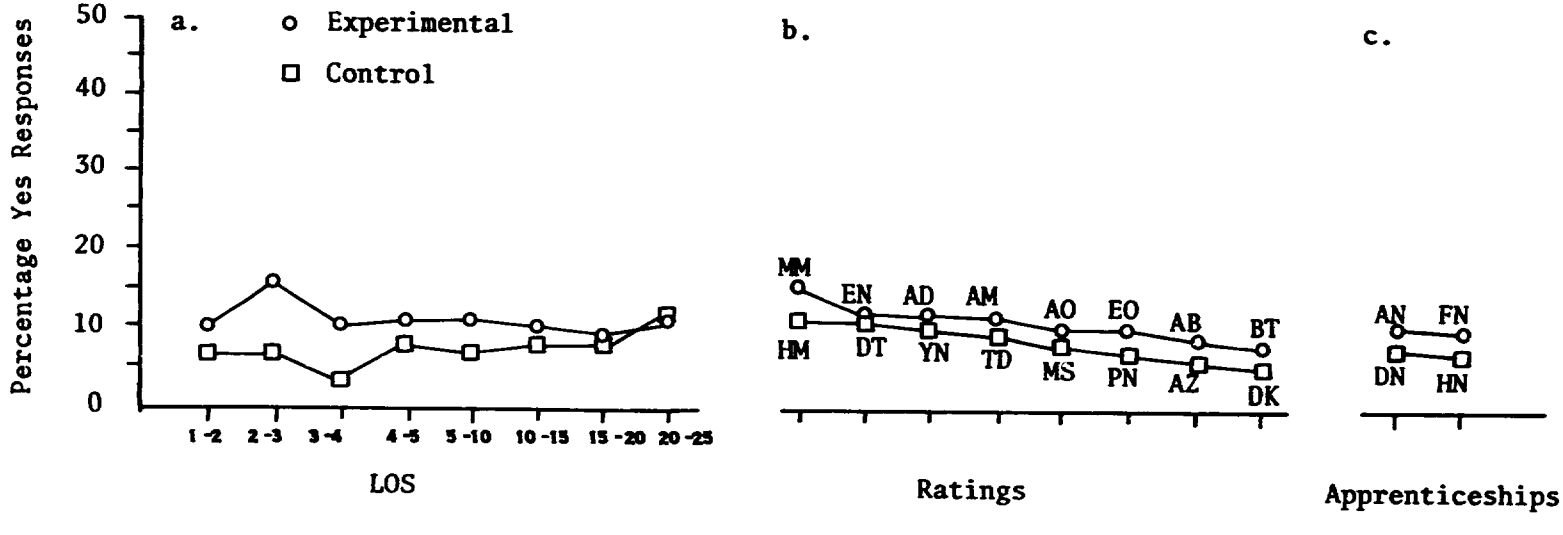


Figure H-2

Percentage of affirmative responses to Question 2: Do you now or have you ever had head noises?

The findings shown in Figure H-3a would not be anticipated based on the hearing test data (Figure 7). One would expect a significantly increased difficulty in understanding speech as LOS increases, especially for the experimental group. Figure H-3b, however, shows a consistent separation between the experimental and control groups in response to Question 3, as might be predicted.

Responses concerning noisy job experience prior to military service are shown in Figure H-4. It is interesting to note that older personnel reported a significantly lower rate of pre-service jobs with high noise levels than did the younger personnel. This is true for both the experimental and control groups. Perhaps the availability of jobs, per se, immediately out of high school is greater today than in the past or perhaps there are simply more noisy jobs today.

The findings shown in Figure H-5 may provide at least a partial explanation of the high incidence of hearing loss in the longer LOS categories of the EO and HM ratings (Appendix D). These two ratings had the highest rate of combat assignments. Note that there is no appreciable difference between the findings for the experimental and control groups for this factor.

There is a significant difference between the experimental and control group findings relating to noisy hobbies or activities (Figure H-6a). This is especially evident through the first five years of military service where the experimental groups demonstrate a much greater involvement in off-job noise exposure. While the control group remains roughly stable over time for this parameter, the experimental groups' participation declines significantly over time. From Figure H-6b, it is seen that a clear separation exists between the two groups for this parameter. Interestingly enough, EOs report the least off-job noise exposure of any of the experimental ratings (they had the highest prevalence of high frequency hearing loss). Also, it appears that personnel in the "quieter" ratings do not care for noise on or off the job.

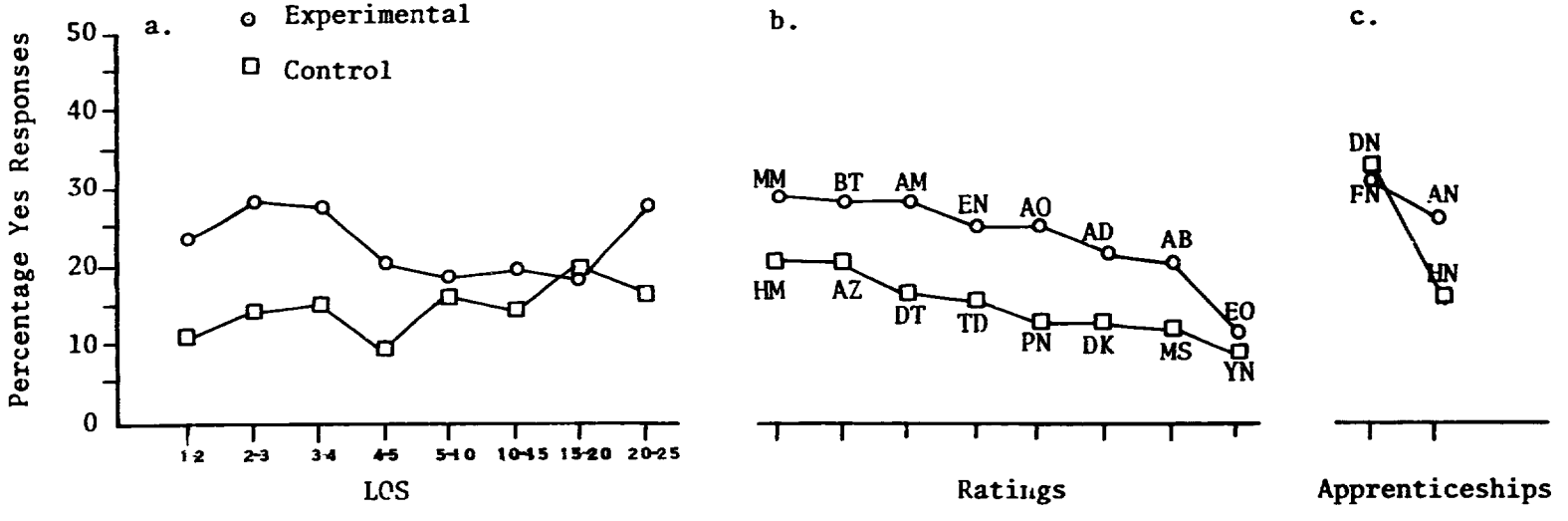


Figure H-3

Percentage of affirmative responses to Question 3:
Do you have problems understanding speech in any situation?

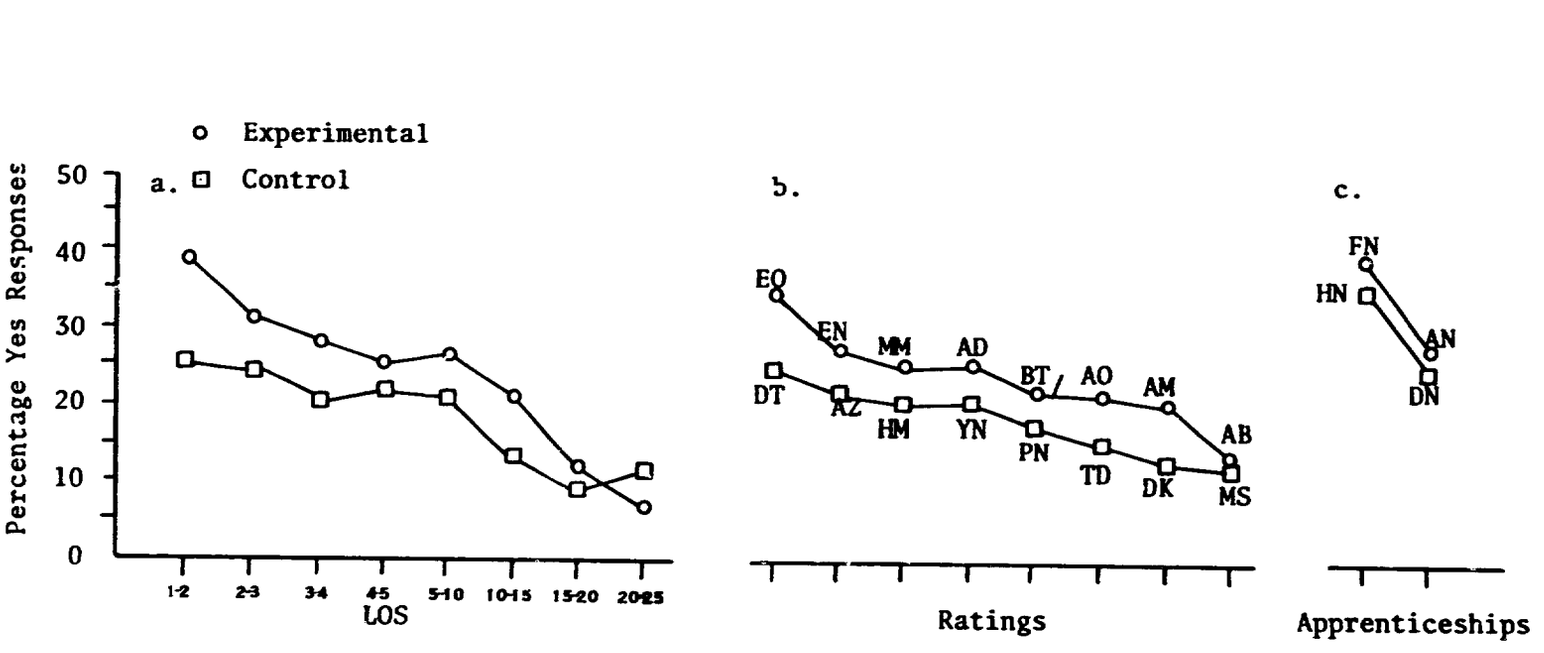


Figure H-4

Percentage of affirmative responses to Question 4:
Did you work at a noisy job prior to military service?

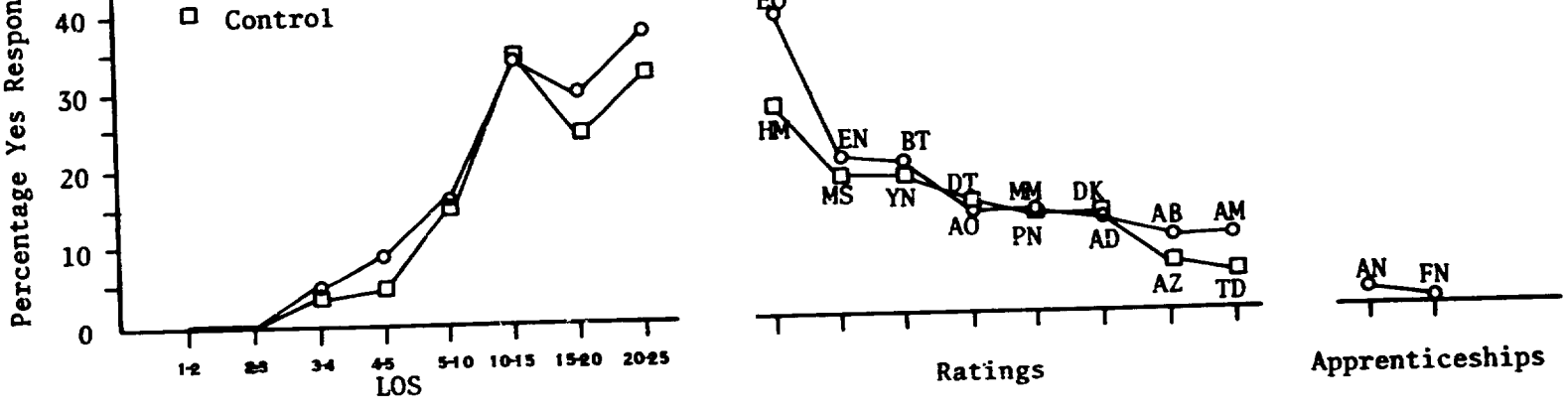


Figure H-5

Percentage of affirmative responses to Question 5:
Have you ever been in combat?

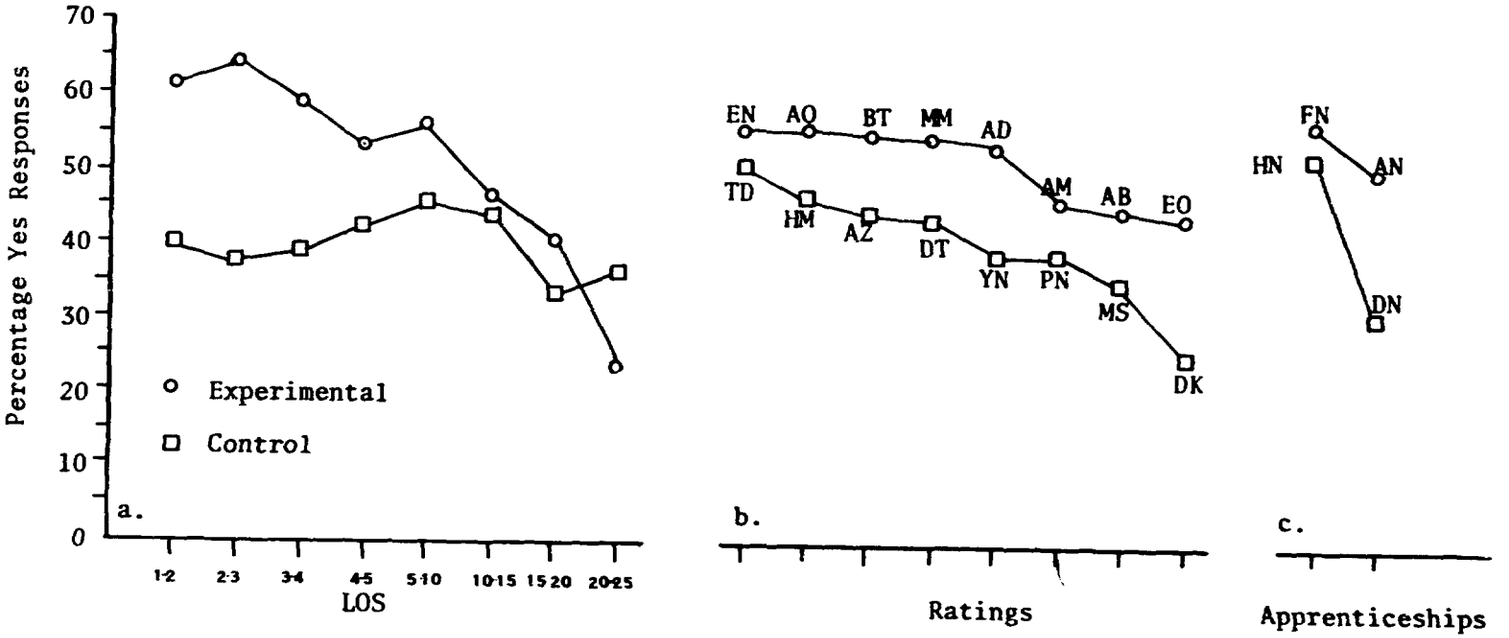


Figure H-6

Percentage of affirmative responses to Question 6: Do you now or have you in the past participated regularly in any hobby or off-job activity that is typically noisy?

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NAMRL - 1251	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Prevalence of Hearing Loss Among Selected Navy Enlisted Personnel		5. TYPE OF REPORT & PERIOD COVERED FINAL 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Ronald M. Robertson, John C. Page, and Carl E. Williams		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Aerospace Medical Research Laboratory Naval Air Station Pensacola, Florida 32508		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS MF51.524.023-2004
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Medical Research and Development Command National Naval Medical Center Bethesda, Maryland 20014		12. REPORT DATE September 28, 1978 13. NUMBER OF PAGES 81
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Mr. John C. Page is Head of the Clinical Audiology Branch, Hearing Conservation Service, Naval Aerospace Medical Institute, Pensacola, Florida.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Noise
Hearing
Hearing conservation
Hearing standards
Industrial hearing loss
Human subjects

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

No reliable body of data exists on the prevalence of hearing loss among naval enlisted personnel. Such data are vitally needed, not only to determine the extent to which hearing loss exists in such specialties, but also to further document the urgent need for implementation of hearing conservation programs throughout the Navy. Hearing threshold level data have been obtained on 3010 subjects from 16 Navy enlisted rates, 400 subjects from four apprentice groups and 120 recruits. (over)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The problem of hearing loss is more widespread than was anticipated. In many instances the hearing threshold levels of individuals in control group (least noise exposed) ratings and apprenticeships (HN, DN, HM, DT, MS, YN, PN, DK, TD, and AZ) approached hearing threshold levels of individuals in experimental group (most noise exposed) ratings and apprenticeships (AN, FN, EO, MM, EN, BT, AM, AD, AB, and AO). Overall, 12.5 percent of subjects in the control group and 25 percent of subjects in the experimental group demonstrated significant high frequency hearing loss. These percentages, when projected to the total population within the ratings studied, produce an estimate of approximately 32,000 personnel as having a significant high frequency hearing loss. Considering that this investigation examined only 20 percent of the approximately 80 ratings in the Navy, it is clear that the total number of naval personnel exhibiting hearing loss is indeed formidable.